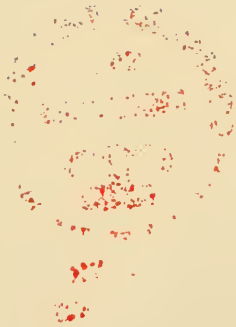
COLUMBIA LIBRARIES OFFSITE
HEALTH SCIENCES STANDARD
HX64060705
RD32 Sm6 1881 Manual of the princi
RECAP

COLUMBIA UNIVERSITY
THE
LIBRARIES
IN THE CITY OF NEW YORK
HEALTH
SCIENCES
LIBRARY



Digitized by the Internet Archive
in 2010 with funding from
Columbia University Libraries

http://www.archive.org/details/manualofprincipl00smit

C. Eugene Gunther M.D.
N.Y. 1882.

MANUAL

OF THE

PRINCIPLES AND PRACTICE

OF

OPERATIVE SURGERY.

BY

STEPHEN SMITH, A. M., M. D.,

SURGEON TO BELLEVUE AND ST. VINCENT HOSPITALS, NEW YORK

BOSTON:
HOUGHTON, MIFFLIN AND COMPANY.
NEW YORK: 21 ASTOR PLACE.
The Riverside Press, Cambridge.
1881.

Copyright, 1879,
By STEPHEN SMITH.

All rights reserved.

RD 32
Sm 6

RIVERSIDE, CAMBRIDGE:
ELECTROTYPED AND PRINTED BY
H. O. HOUGHTON AND COMPANY.

PREFACE.

The Handbook of Surgical Operations, prepared by the writer in 1862, though specially designed for military practice, was received with much favor by the profession at large. The request has often been made, by both medical practitioners and students, that the plan of the work should be enlarged so as to include the general operations of surgery in civil practice. The present work is the result of an effort to realize that object within the limits assigned, namely, general operations in surgery, the organs of special sense being excluded. The arrangement of matter and the structure of the text require explanation: (1.) In defining the qualifications of the surgeon no attempt is made to establish an ideal standard of excellence. On the contrary, the true estimate of his qualifications is found in the civil obligation which he assumes whenever he undertakes the care of any case. The judicious discrimination which the common law makes of the relation of qualifications to time, place, and circumstances, are far more important than have ever been defined by any professional code. (2.) It follows that as conformity to the established principles of an art is a fundamental requirement of the civil obligation upon those who practice such art, a manual of this character should, as far as practicable, illustrate those principles. It has, therefore, been a constant effort to give to the text the highest degree of authority, by embodying the teachings of recognized authorities on every subject, so far as they conform to what is believed to be the present standard of surgical opinion and practice. And to the same end the various subjects have for the most part been submitted for revision to competent authority and received its sanction; where special importance is attached to such revision, the name of the person consulted appears in small capitals. New theories and methods are noticed in the leading text only so far as they are

obviously correct, or are sanctioned by the weight of responsible names. (3.) In order to economize space, the opinions, and, as far as practicable, the language of writers, have been incorporated into a condensed, uniform text, due credit being given by marginal references to the names of authors. The larger type is designed to embody the principles and practice now established by authority, whilst the smaller type is employed for explanatory or supplemental matter.

In the general treatment of subjects something more has been attempted than to give the mere formal details of operations. Forty years ago, the author[1] of the most popular and useful manual of operative surgery ever issued, remarked in the preface, that such a treatise, to satisfy all the requirements of the age, should for each operation discuss indications, exactly study the surgical anatomy, review all the proceedings, and after mature examination and judicious choice of the best, describe the manipulation with all the necessary details, point out the different methods of dressing, give a statistical account of successes and failures, and, finally, in autopsies seek the causes of death in fatal cases. Although it is quite impossible, in the limited space of a manual, to discuss these and the many new questions relating to operations, yet the suggestions of that eminent author have been constantly borne in mind, and as far as practicable followed. No stereotyped method of treating subjects has been pursued, but each has been considered in such manner as seemed best adapted to present all necessary facts in the most available form for the practitioner.

The illustrations, though ordinary in kind, form an important feature of the work. They were selected for the purpose of illustrating special features in each case, and only such parts have been used as were essential for that object. They have been derived from many sources, as from the former work, from works on surgery, medical periodicals, and from manufacturers of instruments.[2] A large number were specially drawn for the work, some of which are original studies of the artist.[3] Due credit is given, as far as possible, to the source from which each was derived.

[1] J. F. Malgaigne.

[2] Tiemann & Co.; Reynders & Co.; Codman & Shurtleff.

[3] W. C. W. Glazier, M. D.

CONTENTS.

I.

THE PRINCIPLES.

CHAPTER		PAGE
I.	— The Obligation	1
II.	— The Examination	5
III.	— The Preparation	11
IV.	— The Hæmorrhage	17
V.	— The Anæsthesia	26
VI.	— The Operation	31
VII.	— The Emergencies	34
VIII.	— The Dressing	39
IX.	— The Appliances	50
X.	— The Repair	56
XI.	— The Cicatrization	73

II.

THE OSSEOUS SYSTEM.

THE BONES; THE JOINTS.

XII.	— The Injuries of Bones	80
XIII.	— Diseases of Bone and Special Operations	101
XIV.	— General Operations on the Bones	111
XV.	— Injuries of Joints and Special Operations	147
XVI.	— Diseases of the Joints and Special Operations	154
XVII.	— General Operations on the Joints	168

III.

THE MUSCULAR SYSTEM.

THE MUSCLES; THE TENDONS; THE FASCIÆ; THE BURSÆ.

XVIII.	— Injuries of the Muscular System, and Special Operations	193
XIX.	— Diseases of the Muscular System, and Special Operations	196
XX.	— General Operations on the Muscular System	202

IV.

THE CIRCULATORY SYSTEM;

THE HEART; THE ARTERIES; THE CAPILLARIES; THE VEINS; THE LYMPHATICS.

XXI. — The Injuries of the Circulatory System and Special Operations 213
XXII. — Diseases of the Circulatory System and Special Operations 220
XXIII. — General Operations on the Circulatory System . 232

V.

THE NERVOUS SYSTEM..

THE BRAIN; THE SPINAL CORD; THE NERVES.

XXIV. — Injuries of the Nervous System, and Special Operations 275
XXV. — Diseases of the Nervous System and Special Operations 283
XXVI. — General Operations on the Nervous System . . 291

VI.

THE TEGUMENTARY SYSTEM.

THE SKIN; THE HAIR AND GLANDS; THE NAILS.

XXVII. — Injuries of the Tegumentary System and Special Operations 302
XXVIII. — Diseases of the Tegumentary System and Special Operations 313
XXIX. — General Operations on the Tegumentary System . 325

VII.

THE DIGESTIVE ORGANS.

XXX. — The Lips 340
XXXI. — The Palate 350
XXXII. — The Alveolar Process; The Salivary Glands; The Tonsils 358

XXXIII. — The Tongue 367
XXXIV. — The Pharynx; The Œsophagus 375
XXXV. — The Stomach 381
XXXVI. — The Duodenum; The Jejunum; The Ileum . . . 388
XXXVII. — The Cæcum; The Colon 396
XXXVIII. — The Rectum 405
XXXIX. — The Anus 416
XL. — The Liver; The Spleen 426
XLI. — The Abdomen 431
XLII. — The Hernlæ of the Abdomen 436

VIII.

THE RESPIRATORY ORGANS.

XLIII. — The Nose: The Nasal Fossæ; The Antrum . . 455
XLIV. — The Larynx 470
XLV. — The Trachea; The Thyroid Body; The Bronchi . 483
XLVI. — The Lungs 490

IX.

THE URINARY ORGANS.

XLVII. — The Kidneys 497
XLVIII. — The Urinary Bladder 502
XLIX. — The Urethra 527

X.

THE GENERATIVE ORGANS.

THE MALE ORGANS.

L. — The Testicles 545
LI. — The Prostate Gland 552
LII. — The Penis 555

THE FEMALE ORGANS,

LIII. — The Ovaries 559
LIV. — The Uterus 566
LV. — The Vagina 571
LVI. — The Vulva 576
LVII. — The Mammary Glands 585

XI.

THE EXTREMITIES.

LVIII. — Amputation 590
LIX. — Deformities 633
LX. — Compensative Appliances 649

INDEX 663

OPERATIVE SURGERY.

I.

THE PRINCIPLES.

CHAPTER I.

THE OBLIGATION.[1]

The Principles of an art are those general truths and maxims which competent authority has established. If an art is progressive, like operative surgery, the principles cannot all be fixed and permanent, but must change with the advance of scientific improvements. These changes take place gradually, for alleged new truths do not obtain the weight and importance of principles until they have received the sanction of recognized authority. In order to determine, therefore, the principles of an art susceptible of constant improvement, it is necessary to consult the opinions of its acknowledged exponents at the particular period under review. An adequate knowledge of the principles of operative surgery, as thus established, is a part of the civil obligation of the surgeon, for the standard of judicial estimation of his responsibilities, in any case, is an intelligent application of those principles in practice.[2] And the same criterion is required by the professional obligation. But this measure of success implies special qualifications, for though capital operations are attended with a certain degree of risk to life, and the minor or insignificant may have a fatal issue from causes which are not always easily determined,[3] it is nevertheless true that the results of operations depend largely upon the capacity and qualifications of the surgeon.[4] Whoever undertakes to practice any art or profession assumes an obligation, both civil and professional, which, though implied, has all the force and validity of a formal contract.[5] In legal construction, this obligation requires that every practitioner of operative surgery shall, (1) possess that degree of knowledge, skill, and experience which is ordinarily possessed by the professors of the

[1] Hon. M. R. Waite, Chief-Justice, U. S.
[2] Espinasse.
[3] S. D. Gross.
[4] C. Sédillot.
[5] Justice Tyndall.

same art or science; and which is regarded by those conversant with that employment as necessary and sufficient to qualify him to engage in its practice; (2) that he use reasonable and ordinary care in the exercise of his skill and the application of his knowledge to accomplish the purpose for which he was employed; (3) that he use his best judgment.[1]

I. QUALIFICATIONS.

The measure of qualifications which the surgeon must bring to the discharge of his duties is defined to be competent knowledge of the principles of the art and adequate skill in the application of that knowledge. But there can be no fixed limit to these qualifications, for the required knowledge and skill rise in proportion to the value and delicacy of the operation.[2] Every case necessarily has its own peculiarities, and, therefore, there can be no universal standard of treatment established.[3] Even the most trivial operation is liable to serious complications, requiring for its successful management a wide range of knowledge, a high order of skill, and the largest experience. Recent judicial decisions and legal opinions have more distinctly defined these qualifications.

1. **The knowledge** required is that reasonable degree of learning which is ordinarily possessed by others of the profession;[4] or the requisite knowledge to enable the surgeon to treat such cases as he undertakes with reasonable success, or understandingly and safely;[5] or, again, he must have that degree and amount of knowledge of the science which the leading authorities have pronounced as the result of their researches and experience up to the time, or within a reasonable time, before the issue or question to be determined is made.[6] It follows from those decisions that the surgeon who fully complies with the obligation must have adequate knowledge of the medical sciences, anatomy, physiology, and pathology, and of the practical branches, medicine, surgery, obstetrics, and therapeutics. He must also be familiar with the current opinions of the leading authorities, for as surgery is a progressive science his patient is entitled to the benefits of new discoveries.[7] Without such knowledge no case can be treated understandingly and safely.

2. **The skill** implied in the contract is the ordinary skill of the profession[8] or a reasonable, fair, and competent degree of skill.[9] The lowest grade of qualification which is now regarded as admissible is the least amount of skill compatible with a scientific knowledge of the healing art.[3] But skill in operative surgery requires manual dexterity. The success of the operation may depend upon the dex-

[1] Leighton *v.* Sargeant. [2] Bouvier. [3] J. Ordronaux. [4] Branner *v.* Stormont. [5] Patten *v.* Wiggin. [6] J. J. Elwell. [7] McCandless *v.* McWha. [8] Justice Story. [9] Justice Tyndall.

terity of the surgeon alone, when he must employ the skill requisite to accomplish it;[1] but if the operation is a part of the general treatment of the case, the degree of manual dexterity must be equal to that exercised by other surgeons at the time and in the place where the act is performed.[2]

II. CARE.

The degree of care bestowed on each case must be such as surgeons of common prudence would employ.[3] There is no standard of comparison by which to determine what is ordinary or reasonable care, but each individual case must stand upon its own merits.[4] In the care of any case the surgeon must conform to established precedent, and be diligent in the application of remedial measures.

1. **Conformity** to established rules of practice has, from the earliest periods, been rigidly exacted. It is held that any deviation from the established practice shall be deemed sufficient to charge the surgeon with malpractice, in case of an injury arising to the patient.[5] This rule is designed to protect the community against reckless experiments, while it admits the adoption of new remedies and modes of treatment only when their benefits have been demonstrated, or where, from the necessity of the case, the surgeon must be left to the exercise of his own skill and experience.[6]

2. **Diligence** in the care of a case is the faithful application of knowledge and skill. The possession of the requisite qualifications, and failure to employ them sedulously for the benefit of the patient, is negligence, and negligence is as much a fraud upon the employer as want of skill, for it is upon the diligent application of skill that the problem of success must rest.[7] It is held that whenever any important step in the treatment of disease is neglected, or any important stage of it is overlooked which might have been used for the benefit of the patient, then it may be averred that the surgeon has been guilty of negligence.[7]

III. GOOD JUDGMENT.

In every case, good judgment must characterize the professional acts of the surgeon. By good judgment is understood judgment based upon a knowledge of the medical sciences.[8] There are few diseases where a single course of treatment can be adopted; in general, differences of opinion must exist as to the best course to be taken.[9] Good judgment wisely determines the course to be pursued, and applies appropriate means to secure given results. Hence it follows, good

[1] Ohio case. [2] Haire v. Reese. [3] Cater v. Fernald. [4] Hilliard. [5] Espinasse. [6] Carpenter v. Blake. [7] J. Ordronaux. [8] Courtney v. Henderson. [9] Leighton v. Sargeant.

judgment and manual dexterity are essential elements in the practice of operative surgery. Though both are important, they are not equally so; good judgment in the selection and employment of remedial measures excels manual skill in effecting favorable results in cases where both are required.[1] When happily combined in the same person they give the highest measure of success. But as these qualities are susceptible of unlimited improvement by culture, the surgeon is culpable who does not attain to that degree of skill which the civil obligation exacts.

IV. RESPONSIBILITY.

The civil obligation imposes important individual responsibilities upon the surgeon. He must exercise his best skill and judgment in every case.[2] And wherever great and extraordinary skill is possessed, causing his employment exclusively on that account, he must bestow it to the full measure of his ability, since the exceptional degree of that skill is the moving consideration to his employment.[3]

The responsibility also for the success of every operation which he performs is individual. He may decline to undertake any case,[3] but having accepted the trust, he alone is responsible for the results of treatment.[4] Neither the attending physician, nor the consulting surgeon, assumes any portion of the obligation. Throughout the entire case the conduct of the surgeon must be characterized by fidelity to the patient, and a uniform and consistent application of skill in the treatment of the disease. Failure at any time to meet the ordinary indications in the case vitiates the entire attendance, for the obligation is continuous to the termination.[5] In view of these facts, it is important that the surgeon should make every case which he undertakes peculiarly his own. He should forecast every possible source of failure, and be prepared for every possible emergency, for he is the most ready to take responsibilities and to bear them lightly who can best estimate what are the risks and difficulties which he is to incur.[6] In diagnosis, prognosis, operation, and after treatment, his opinions should be formed, and his course of procedure marked out and followed, without being unduly influenced by the solicitation of patient or friends, or the suggestions of consultants. Every step should be taken with that painstaking care and deliberation which leaves no ground for a charge of ignorance, negligence, or want of skill. Thus the surgeon not only fulfills the just requirements of the obligation, civil and professional, but secures that confidence and self-reliance in every stage of progress and in every emergency so necessary when great responsibilities are assumed.

[1] J. Ashurst, Jr. [2] Paten *v.* Wiggin. [3] J. Ordronaux : J. J. Ewell.
[4] F. C. Skey. [5] Bellinger *v.* Craigue. [6] Sir J. Paget.

CHAPTER II.

THE EXAMINATION.

In order to form a judgment which will guide to the proper treatment of any case involving the question of an operation, there must first be a systematic examination as to the nature of the disease, the condition of the patient, and of all the circumstances favorable or unfavorable to success. While it is true that the unfavorable issue of cases may come of things which nothing far short of omniscience could have detected beforehand, yet often the disaster can be directly traced to some oversight, carelessness, or want of judgment or of skill.[1] No operation should be performed except in urgent cases, unless the patient's history and general condition have been scrupulously inquired into;[2] even in cases demanding an immediate operation, there may still be opportunity for inquiry as to previous health and habits, and to examine the heart and lungs, and perhaps the secretions of the kidneys. In delayed operations, the surgeon would be culpably negligent who did not inquire into constitutional peculiarities, and functional and organic affections, for the timely discovery of morbid conditions of the viscera renders possible the use of appropriate remedies before the operation.

I. DIAGNOSIS.

The first step in the management of the case is the determination of the nature of the disease. The course of inquiry must be most judiciously and systematically made, for on it depends the course of treatment to be pursued. An error may be attended with the most serious consequences by leading to the omission of timely and important remedies, or to the use of measures which are detrimental.[3] It may thus set in operation a series of pernicious influences for which the surgeon will be held rigidly responsible.[4] It is not always possible to discover the exact condition of a diseased or injured organ or tissue, and it is a fact of daily experience that surgeons of the greatest skill will differ in their diagnosis of the nature of a given disease,[5] but failure to detect the more obvious and essential changes will always be construed as culpable negligence. As it is admitted that errors in diagnosis are due in a great majority of cases to haste and inattention,[6] the surgeon should seek, by thorough and patient investigation of every case, aided by the most approved instruments and appliances, to protect himself from such a charge. The ele-

[1] Sir J. Paget. [2] G. W. Callender. [3] G. H. B. McLeod. [4] J. Ordronaux. [5] Walshe *v.* Sayre. [6] S. D. Gross; T. Holmes.

ments of a correct diagnosis are found in (1) the history of the patient; (2) the progress of the disease; and (3) the physical examination. An investigation which will discover and place in their proper relations all the important facts bearing on the nature of the disease, must develop the following specific inquiries, under the several heads above given : —

1. **The history** of the patient includes the following series of inquiries: sex, in its tendencies to special forms of disease at different periods of life, and to nervous phenomena; age, as it affects the development of bones and organs, the integrity of tissues, and the occurrence of organic and malignant diseases; heredity, in the perpetuation of diseases and peculiarities of ancestors; previous diseases, which leave their sequelæ, as syphilis, scrofula; occupation, which develops special maladies, as necrosis of jaw from phosphorus; habits, with which certain affections are likely to be associated, as venereal diseases with prostitution, nervous derangements with masturbation; social condition, as it is related to secret or conjugal vices of the sexes.

2. **The progress** of the disease relates to the following special subjects: date of the attack or injury, on which depends the progress of the malady; alleged changes, which may be the clue to the true cause; symptoms which, taken in their order of development, give much of the clinical history, and afford reliable data for a differential diagnosis; the present attitude, form, and condition of the part compared with the past; the operations which may have been performed and their results; the course of treatment and its most important effects, which may be the very touchstone revealing the nature of the complaint.[1]

3. **The physical** examination must be made with all necessary aids and appliances, visual, manual, and instrumental. *First:* Color determines the circulation in a part; form indicates the existence or non-existence of enlargements of regions, when deciding as to tumors, dislocations, fractures; transparency reveals the presence of serum, as in hydrocele. *Second* : Consistence must be noted in inflammatory swellings and tumors, fluctuation in collections of fluids; crepitus in fractures; crepitation in collections of air or gas beneath the skin. *Third:* The exploring needle detects the consistence and contents of swellings and tumors; the hypodermic syringe withdraws the fluids of abscesses and cavities; the trocar[2] removes pieces of muscle for examination; the microscope determines histological peculiarities; the ophthalmoscope reveals the deep structures of the eye, the laryngoscope of the laryngeal passages, the speculum of the ear, the vagina, and rectum, and the urethroscope of the urethra and urinary bladder.

[1] G. H. B. McLeod. [2] Duchenne.

II. PROGNOSIS.

The prognosis is an estimate of the results which will follow any operation. It must depend primarily upon the knowledge obtained in the diagnosis, and secondarily upon that larger inquiry which seeks to discover tendencies and conditions affecting the ultimate issue of diseases, and operative procedures undertaken for their cure. The chances of recovery after operations are so largely influenced by the previous state of the patient's constitution,[1] that special inquiry should be made as to former diseases and their effects, and the existing organic and functional integrity of every important organ. Due attention should also be given to mental and physical peculiarities, and to those surrounding conditions which more or less directly modify the ordinary course of the malady under observation. The following considerations have a relative importance, and should have proper weight in deciding the probable issue of an operation :

1. **The native** bears operations better than the immigrant.

2. **The sex** which has the greatest endurance is the female.[2]

3. **The age** is not in itself a barrier to any necessary operation,[3] but with it we connect the most regular average difference in capacity to bear operations;[4] the most favorable period is between five and fifteen; the next, between fifteen and thirty; after thirty the risk to life is more than twice as great as it was at the same period after birth.[5] Young and healthy children [4] are in danger through shock, aggravated by pain, but bear very well the loss of blood, and are little liable to pyæmia after wounds. Old persons [4] are likely to have organic diseases and degeneracies, and feeble circulation, inducing congestions, due to sinking of the blood in the lungs, liver, intestines, and other dependent parts; are liable to die of shock, or mere exhaustion, and do not bear losses of blood, lowering of temperature, or want of food; they convalesce slowly, or after partial recovery fade, waste, and die; but the thin, dry, tough, clear-voiced, and bright-eyed, with good stomachs and strong wills, muscular and active, bear very well all but the largest operations.

4. **Constitutional Diseases** [4] influence operations as follows: Scrofula gives a considerable mortality, but its ill effects are seen chiefly in the imperfect healing of wounds, the swollen cellular tissue, the thin and lowly organized cicatrix, or indolent ulcers and sinuses; in the large majority of chronic cases the removal of a scrofulous part is followed by improved health, but the patient remains scrofulous, and, if old, may not bear confinement well; syphilis is liable to delay reparative action, and the operation in those who have tertiary sores may be followed by renewed tertiary symptoms; rheumatism

[1] N. Chevers. [2] W. S. Savory. [3] S. D. Gross. [4] Sir J. Paget. [5] T. Holmes.

and gout predispose to structural changes of arteries and kidneys, and to organic diseases of the heart; cancer contra-indicates operations only in its later stages, when the general health is failing; anæmia is not a bad condition in which to operate, wounds heal slowly and soundly, but if erysipelas or like casualties supervene patients are less likely to recover.

5. **Habits and Temperament** [1] should be duly considered; intemperance increases the dangers of operations in proportion as it is habitual; slight intemperance is much worse than occasional great excesses; avoid operating on confirmed drunkards, unless compelled by the necessity of the case; operations are hazardous on all persons who require stimulants before they eat or work; over-eating is closely allied to intemperance in increasing the dangers of operations, especially if the over-eating is of meat and other nitrogenous foods; the over-fat are a bad class, when their fatness is not hereditary, but due to over-eating, soaking, indolence, and defective exeretions, their pendulous bellies indicating omental fat, and deficient portal circulation; persons in whom the vital processes are weak, but without morbid action, repair wounds feebly, and are especially liable to real diseases of the blood and tissues, and operations should be deferred, if practicable, to some period of better health, for fear of local failure, rather than of incurring any unusual risk of life; allied to this class are the cold-blooded, with cold, damp hands and feet, dusky appearance of vascular parts, feeble circulation, small pulse, slow digestion, constipation; nervous persons, who are exceedingly mobile and excitable, whether in their sensitive or motor organs, their whole cerebro-spinal system being altogether too alert and vivacious, pass through the consequences of operations with as great impunity as any other class; malarial affections do not contra-indicate operations, but in the course of convalescence ague fits, resembling those which precede pyæmia, may occur.

6. **Deranged or diseased conditions** [1] of organs variously affect the results of operations; of the digestive organs, gastric dyspepsia is followed only by flatulence, unless vomiting is a symptom when anæstheties are liable to excite emesis, with dangerous prostration; great caution is required with those whose biliary secretions are habitually unhealthy, or who have been often jaundiced, or who have a sallow, dusky complexion, dry skin, dilated small blood-vessels of the face, sallow and bloodshot conjunctivæ, symptoms which indicate deranged functions and abdominal plethora; enlargement of the liver, whether amyloid or fatty, is often coincident with chronic diseases of the bones in children, and either tends to cause death by exhaustion, or secondary hemorrhage; of the organs of circulation,

[1] Sir J. Paget.

affections of the heart are not serious hindrances to recovery from operations; shock and loss of blood are attended with more than ordinary risk in persons whose hearts are feeble or embarrassed by valvular obstruction, but a rapid or irregular pulse, without organic disease of the heart, and with respiration not exceeding twenty or twenty-five, does not contra-indicate an operation; degeneracies of the arteries are only serious when general in the extremities, especially the lower, rendering primary hemorrhage difficult of control, and secondary hemorrhage more frequent and dangerous after amputation, and so interfering with nutrition that destructive suppuration is liable to occur, with slow and imperfect healing of the wound; diseased veins complicate operations only when varicose, and cut through, as in amputations, thus exciting inflammation; of the diseases of the respiratory organs, chronic bronchitis and emphysema, especially in old people, render operations extremely hazardous, owing to imperfect respiration, cough, and loss of sleep; phthisis, when progressive, adds greatly to the dangers of operations, from the consequent fever, loss of food, and pain, but, when chronic, operations are advisable, which relieve the system of painful and wasting local diseases; persons suffering from long-standing strumous affections, with the appearance only of tubercular disease, may be greatly benefited by the removal of the diseased part; menstruation and pregnancy are conditions rendering operations undesirable.

7. **Various other affections**[1] modify the prognosis as follows: severe operations during the stage of shock after injuries, and during the period of acute inflammation, with high temperature, are dangerous; spreading erysipelas, cellulitis, and gangrene add so much to the dangers of severe operations, that the chances of life are best when only the ordinary treatment is followed; avoid operations in acute pyæmia, when there are rigors once or more in a few days, and profuse sweatings, with very rapid pulse and breathing, and with delirium and rapid wasting, or with dry tongue and yellowness of skin, or any considerable number of these symptoms; but an operation is justifiable in chronic pyæmia when there is wasting and sweating, with the formation of abscesses here and there, and the injured part is manifestly useless and a source of irritation or of exhaustion; croup does not contra-indicate tracheotomy, nor peritonitis herniotomy, which are operations of necessity, and are not materially affected by the general acuteness of the existing affections; of the diseases of the kidney, those associated with the constant presence of albumen in the urine predispose operated patients to erysipelas and pyæmia; pyelitis renders operations, as lithotomy, lithotrity, and even catheterism dangerous, owing to the liability to urinary

[1] Sir J. Paget.

fever and retention of the materials of urine in the blood; of the diseases of the nervous system, delirium tremens is an indication of a complexity of risks, and forbids all large operations, except from compulsion; dysentery and acute diarrhœa are unfavorable, especially when irritative fever, with cellular inflammation, is present; slight and transient diarrhœa is serious only when it occurs in the old or young, or exhausted; constipation is unimportant, but, when habitual, copious evacuations may prove dangerously prostrating to the feeble; insanity renders patients more or less indifferent to pain and local injuries, but they recover from chronic ailments with difficulty. External conditions unfavorable to an operation are the epidemic prevalence of erysipelas, or low forms of fever, and an atmosphere contaminated by the presence of any contagious diseases.

III. DECISION.

The decision must be based upon the preceding investigation relating to the diagnosis and prognosis. The question of an operation enters as a new and most important element in the case, and always demands the most serious consideration, for cutting operations must be regarded as injuries inflicted at the will of the surgeon, which may destroy a person enjoying comparatively good health, or fatally aggravate other but not serious affections. An operation is not justifiable when the patient can be cured by any reasonable medical or other means; and if the disease can be cured by a bloodless operation, as well as by one with cutting, choose the bloodless method, for the danger is comparatively slight when the operation does not involve the injury of tissues.[1] Any operation is of undoubted propriety, which is immediately necessary to save life, as tracheotomy in laryngeal obstructions; excision of poisoned wounds; or when it is less severe than other measures, as excision of small growths, instead of employing caustics; or when it is the only measure possible, as amputation of crushed limbs; or the last resort, all other suitable remedies having failed, as herniotomy in strangulated hernia. But frequently the question of operation is involved in doubt and uncertainty, often requiring for its proper solution a nice appreciation of pathological conditions, operative procedures, and reparative processes. It is a well established fact that surgeons may honestly differ in their views as to whether an operation would produce a cure, or be of some benefit, although not a radical cure; or whether the benefit would justify the operation; or, finally, whether the operation could be performed at all without destruction of life.[2] In whatever form the question of an operation is presented, all of the evidence for and against it should

[1] Sir J. Paget. [2] Walsh *v.* Sayre.

be personally considered by the surgeon with judicial impartiality. In many instances it can only be determined by the judicious discrimination of existing conditions, which are often complex. He should never be over-persuaded by patient or friends, nor unduly influenced by counsel, to operate against convictions deliberately formed; neither the consent, nor even request, of the patient can justify such an operation.

The Consent[1] of the patient, or of those responsible for him, to the operation should, if possible, always be obtained. If he is not capable, as when intoxicated or comatose, or if he is a child, and parents or guardian are inaccessible, operate only from clear necessity. In order that he or they may form a correct judgment, communicate the decision, and the reasons that have led to the conclusion; make every necessary explanation as to the nature of the injury or malady, its probable course and termination, and the advantages, disadvantages, and liabilities of the proposed operation; thus you will discharge every obligation, and remit to the patient, or friends, or guardian, the responsibilities of a final judgment as to the course of procedure. As far as practicable, the deliberations of the patient and his advisers should be influenced by no other considerations than those presented by the surgeon. Should the decision be favorable to an operation, the patient again returns to the surgeon's care, and a new series of obligations is incurred. The preparation for the operation, its manual performance, and the after treatment, present questions which will tax his knowledge, skill, and care.

CHAPTER III.

THE PREPARATION.

No ingenuity of conception or brilliancy of execution of the operator can excuse the neglect to secure, by previous preparation, every possible advantage which can in any way, however trivial, minister to success; even a successful issue cannot justify the surgeon in subjecting his patient to an avoidable risk.[2]

I. PATIENT.

The first care must be given to the patient. It is important that every organ, and the entire system, be so prepared for the injury about to be inflicted, that the issue will be favorable: for the timely discovery of morbid conditions of the viscera, and the use of appropriate remedies before the operation, might, in a large proportion of

[1] F. C. Skey. [2] W. S. Savory.

cases, prevent disastrous results.[1] The effects of habits of excessive bodily indulgence in food and stimulants may be amended in a comparatively short time; previous rest, important to the recovery of the part about to be operated upon, may be secured;[2] slight derangements, which are readily amenable to treatment, may at once be corrected, such as indigestion, constipation, diarrhœa; grave affections of the kidneys, liver, heart, lungs, and nervous centres may be so improved, or the system so protected, that the operation will not be serious. Even cold-blooded persons, with feeble circulation, when suitably prepared by tonics, as iron, improve their condition, and bear operations well, being singularly little liable to erysipelas, pyæmia, and other disorders of the blood.[3] The patient should be placed under the most favorable hygienic conditions; pure air, suitable exercise, wholesome food, and undisturbed sleep are important features in the final preparation; the morale must, as far as possible, be sustained by such assurances as will secure mental quietude and hopefulness as to the result of the operation;[4] do not exaggerate its nature, but speak encouragingly of it, and of its prospective success.[5] Finally, as a severe shock to the nervous system, produced by an exhaustive surgical operation and prolonged anæsthesia, may for a time so paralyze the stomach that digestion ceases, or is greatly impaired, and the food that it contains at the moment may undergo such putrefactive changes as will render it an irritant, the food taken within six hours of the operation should be quickly assimilable, and in limited quantities; milk is, in general, the best food for this purpose, especially with children, to which may be added a small amount of whiskey; a warm, well-seasoned, and well-cooked cup of broth, or a fragrant cup of hot coffee and milk, may be preferred by the adult.[6]

II. TIME.

The time appointed must be so fixed as to avoid the error of omission, delay; and of commission, haste, by a careful consideration of the nature of the disease, the condition of the patient, and the surrounding circumstances. It must be immediate when life is threatened, and the operation offers the only chance of recovery, and should be delayed when any of the conditions enumerated would render the operation dangerous to life or abortive in its results. But not unfrequently the disease, the patient, and the circumstances combine to enable the surgeon to appoint the month, the day, and the hour. The employment of anæsthetics has so diminished the fear of operations that the surgeon may exercise his dis-

[1] N. Chevers. [2] W. S. Savory. [3] Sir J. Paget. [4] Ch. Sédillot. [5] A. H. Stevens. [6] F. H. Hamilton.

cretion as to the propriety of informing the patient of the day and hour selected.[1]

1. **The month**[2] should be selected with regard to those meteorological conditions which are known to affect the results of operations, namely, temperature, humidity, and pressure of the atmosphere. The mortality from shock is greatest in dry and least in damp weather; the mortality from fever and pyæmia is greatest in damp and least in dry weather; the month of least mortality from all causes after operations is October in this latitude, which has a high dew-point, medium relative humidity and range of temperature, and low barometer; then January and April; the month of greatest mortality, from all causes after operations, is December, then May and November; the least mortality from shock occurs in October; then in September, August, January, March, and April; the least mortality from fever and pyæmia occurs in February; then in April, November, January, and July.

2. **The day** should be selected with reference to the temperature and humidity of the air. It is always better to defer an operation which falls upon a rainy or inclement day to one of sunshine.[3] The barometer is the best guide, as it forecasts the weather several hours. The following facts[2] are important: The least mortality occurs with an ascending barometer; next when it is stationary; the mortality with a descending barometer is nearly three times greater than with an ascending barometer.

3. **The hour** best adapted for operations, on account of both light and dryness of the air, will fall between 11 o'clock A. M. and 3 o'clock P. M.

III. PLACE.

In the selection of the place reference must be had to the comfort and safety of the patient.

1. **The office** of the surgeon is frequently the most convenient place, but a risk to the patient may thereby be incurred, which it is better to avoid, namely: the liability of rendering a simple operation dangerous by the subsequent imprudent conduct of the patient, as exposure to the elements, excitement, fatigue, or excesses of appetite.[4]

2. **The room** in the private dwelling should be chosen for its accessibility, its size, and its exposure to light at the hour of the operation; the best light in a clear day for delicate operations is reflected from the northern sky. The air[5] of the room in which an operation-wound is inflicted should be as free as it can be made from all forms of putrefactive organisms; it should not immediately communicate

[1] C. Sédillot. [2] A. Hewson. [3] B. W. Dudley. [4] Sir J. Paget. [5] S. D. Gross.

with water-closets, and other sources of defilement, nor be occupied as a living or audience room. The best results after large operations have been obtained when the operating room has been first purified by sulphur, and both operator and assistants have bathed and had their clothes and all the materials used about the wound thoroughly disinfected.[1]

IV. INSTRUMENTS.

In selecting instruments care must be taken that they are of approved utility and in good condition. The surgeon cannot employ rude articles, as a butcher's knife or a carpenter's saw, in amputation, unless he is placed under circumstances which prevent his obtaining suitable instruments.[2] And he is required to employ the more recently devised instruments which have been recommended by the best authorities as preferable to those formerly in use, provided they are reasonably accessible to him. They must be in good order, as dull knives, broken forceps, imperfect saws, seriously complicate operations. They must, finally, be kept in a state of scrupulous cleanliness, as blood and pus may convey contagion to the person next operated, and rust and filth may fatally poison a wound. The minor apparatus also, as the plaster, the ligatures, the sutures, must be carefully selected, for many an operation has been spoiled by bad silk, or needles, or something that was thought too trivial for care.[3] Every practitioner should know how to select and take proper care of instruments. In order to do this intelligently he must understand something of the mechanism of instruments.

1. **The materials**[4] of which the blades of general operating instruments are made are steel, silver, platinum, gold, and aluminum. German steel is used for forceps and blunt instruments, owing to its tenacity; English cast-steel for edge-tools, as it receives a high temper, a fine polish, and retains its edge. Silver, when pure, is very flexible, and is useful for catheters which require frequent change of curve; when mixed with other metals, as the silver coin, it makes firm catheters, caustic holders, and canulated work; seamless silver instruments are least liable to corrode. Platinum resists the action of acids and ordinary heat, and is useful for caustic holders, actual cauteries, and the electrodes of the galvano-cautery. Gold, owing to its ductility, is adapted for fine tubes, as eye-syringes and points of needles. Aluminum is, by extreme lightness, suited for probes, styles, and pessaries. German silver and brass plated instruments are used extensively, owing to their cheapness. The handles may be made of ebony, ivory, shell, or hard rubber. Ebony is more generally used for larger instruments, owing to its durability and neatness. Ivory is more expensive, but makes a beautiful and durable handle. Shell is more used for light instruments, as those of the common pocket-case. Hard rubber makes an excellent handle, combining neatness, lightness, and durability, and is coming more and more into use. Next to materials, the making of the instrument determines its quality; and hence the importance of selecting those manufactured by entirely reliable workmen. If the steel is overheated in the forge the knife will be brittle or rot-

[1] C. Schroeder. [2] Young *v.* Fullerton. [3] Sir J. Paget. [4] Tiemann & Co.

ten; in shaping it with the file the form may be destroyed; in "hardening" and tempering, the steel may be spoiled; in grinding and glazing the instrument may be rendered worthless. In every stage of its manufacture, therefore, the value of an instrument depends upon the personal skill of the workman. The last act of the maker is to polish and sharpen the instrument, and thus adapt it for use.

2. **The tests**[1] of the quality of instruments are as follows: Draw a cutting instrument from heel to point slowly across the *border* of the nail, and it will catch or stop at every "nick;" draw it across the *flat* of the nail, and if at any point the edge is seen to be wiry or smooth, it is soft, and must be reapplied to the hone; but if it becomes serrated, like a fine saw, the edge is brittle, and cannot be remedied by the hone. For pointed instruments, stretch upon a test drum (a contrivance for the purpose for sale by instrument makers) a very thin piece of kid or gold-beater's skin, and push the point through. If it enter smoothly and easily the point is good; but if a slight crackling noise is heard it is defective. If a lancet is tested, see-saw the edge in the opening, and if it glides over without cutting, or cuts roughly, the edge is imperfect.

3. **The preservation**[1] of instruments in good condition requires careful attention to the following details: Select a place always free from moisture and dirt for their safe keeping. Polished instruments should be suspended or placed in velvet-lined cases. After being used, every instrument should be thoroughly cleaned with warm water, and perfectly dried with chamois, or the fire, before it is returned to the case. Silver instruments tarnish when they are exposed to the air, or are brought in contact with hard or soft rubber, caustics, or acids. To preserve the edge and polish of instruments, the surgeon requires two or three small hones, some fine emery paper, two or three screw-drivers, small files, rouge crocus, or other polishing powder, chamois, and gold-beater's or kid skin. Cutting instruments should have their blades kept in perfect order by the judicious use of the hone. Occasionally the blade must be ground by a competent workman. Blunt instruments, which are designed to enter natural or other passages, should be frequently polished with fine emery paper, and then with rouge and chamois skin, in order to remove every particle of rust, and to maintain smooth unblemished surfaces. Saws are sharpened with three-cornered files, applied in the direction of the original cut of the teeth.

The case of instruments which the surgeon must provide depends upon the variety of operations which he undertakes; if limited to trifling operations, he requires only the pocket case; if he perform minor operations, he requires the minor operating case; if he assumes every grade of operation, he must add the general operating case. In selecting any case the surgeon should exercise his own judgment as to the number and kind of instruments, rather than accept the list of the maker, or of any other surgeon. The best assorted case contains many instruments which the general practitioner never has occasion to use.[1]

V. CONVALESCENCE.

The hygienic conditions which surround a patient, the subject of an operation, materially affect the results.[2] Foul air, filthy dressings,

[1] Tiemann & Co. [2] J. E. Erichsen.

indigestible food will thwart the best planned and executed operation.[1] It is, therefore, the duty of the surgeon to secure to the patient all the advantages which healthful conditions afford.[2] These are largely found in the room and its various appointments.

1. **The room** in the private dwelling best adapted for convalescence is on the second floor from the ground; the exposure should be to the south, with ample window space, and with opposite, or partially opposing, windows for thorough ventilation. The size of the room is of slight importance, except as to convenience, compared with the provisions for the outflow of foul air and the inflow of fresh air. Large cubic space does not secure purity of the air, and hence is of minor importance if the necessary amount of fresh air is supplied and properly distributed without unpleasant currents.[3] It would, however, always be wise to provide at least two hundred feet superficial area and three thousand cubic feet of air to the patient and his attendant, each, during the first weeks, to guard against defects in ventilation. As in private residences there are no other motors for changing the air than differences of temperature and movement of the air, which can be excited by heat or wind-fans, these agents must be employed to give motion to the air.[4] The common open fire-place, well heated, furnishes the best heat supply for movements of the air, while the inlet and outlet of air is maintained by raising and dropping the sashes of the windows. The walls should be freshly lime-washed, floors cleaned with carbolic solution; no sink for slops, nor wash-bowls drained into common house-drains, nor water-closet should be in or communicate with the room;[5] the furniture should be as free as possible from absorbent materials; bed and window hangings, carpets, and upholstery are objectionable, and if old are dangerous. Floors, furniture, and wood-work should be cleansed, without water, by rubbing with an absorbent material.[6] Do not place the bed near the wall, in a corner, nor in air draughts.

2. **The ward** of the hospital to which the patient is to be conveyed should be free from suppurating wounds, erysipelas, and low forms of fever; the bed should be exposed to the sunlight, with any necessary screen to the face; it should have at least one hundred feet of superficial area, and four thousand cubic feet of air; the position of the bed should be three or four feet from the wall, with complete ventilation around it; if the tick is filled with straw it must be fresh; if a hair mattress is used, it, with the bed linen, should be clean, and previously well aired and sunned.

3. **The nurse** should be skilled in the care of persons suffering from operations, for frequently success depends upon the skill in

[1] S. D. Gross. [2] Sir J. Paget. [3] J. S. Billings. [4] M. Pettenkoffer. [5] Sir J. Paget; S. D. Gross. [6] A. Smith.

the management of the details of nursing after special operations. Cleanliness of the wound, the patient, the clothing, the room, are of the first importance; the diet and the remedies are to be carefully attended to, and the progress of the case, as indicated by the wound, the pulse, and the temperature, is to be noted at sufficiently frequent intervals to make the record of the case complete in the absence of the surgeon.

IV. ARRANGEMENTS.

The immediate preparations for the operation must be complete in all their details, and, as far as practicable, should be personally supervised by the surgeon. Provide a firm table of suitable height, in all operations of any magnitude, and spread over it two or three folds of blankets. Beds and sofas are no substitutes for the table. Whenever practicable, as in hospitals, a well constructed operating table should always be employed. Provide water, hot and cold, in abundance, with wash-bowls, slop-pails, and jars; also clean towels, and clean old linen; select one competent person to administer the anæsthetic; one trained surgical assistant, who is familiar with the methods of operating, and is prepared to anticipate, or to promptly meet every want or emergency; two ordinary assistants to supply fresh water, cleanse sponges, and answer calls; arrange the instruments which are to be used on a convenient stand, and in the order they will be required, and cover them until the patient is placed on the table; direct the patient to wear clothing loose about the neck and chest, and admitting of full exposure of the parts to be operated upon; administer the anæsthetic after the patient is placed on the table, to avoid the inconveniences of carrying an insensible person, unless through fear, or other disturbing causes, seclusion is necessary.

CHAPTER IV.

THE HÆMORRHAGE.

One of the most important duties of the surgeon is to deal economically with the blood of the patient committed to his charge.[1] Excessive bleeding, due to defective measures for its prevention, is culpable negligence.[2] It is important, therefore, to make suitable preparation for the prevention of hæmorrhage. These measures must be adapted both to control the circulation in the limb, or part, during the operation, and to permanently close the divided vessels after the operation.

[1] F. Esmarch. [2] F. C. Skey.

I. ELASTIC COMPRESSION.

The most perfect method of preventing loss of blood during the operation is by elastic compression so applied as to remove the blood from the part and prevent it from reëntering the vessels.

1. **The elastic bandage**[1] (Fig. 1) is the most serviceable and convenient appliance yet devised to meet all of these important indications. In operations on the lower limb select a bandage made of woven India-rubber, and of sufficient length to extend from the foot to the hip, where it is fastened by a clasp (Fig. 2), or by the rubber tubing sometimes used. While the patient is being brought under the anæsthetic, apply the bandage, with uniform tightness, from the extremities of the toes or fingers, according to the limb about to be operated upon, to a point above the place of operation; where the bandage ends apply the India-rubber tubing, well drawn out, four or five times round the thigh, and connect one end with the other by means of a hook and brass chain, or apply the clasp (Fig. 2); now remove the bandage first applied, commencing with the last turn, and descending to the toes or fingers, leaving the tubing in position; the India-rubber tubing so thoroughly compresses all the soft parts, including the arteries, that not a drop of blood can enter the parts below; even in the most muscular and stoutest individuals we are able thoroughly to control the supply of blood by this simple process; the limb below the tubing resembles completely that of a corpse, and we may operate as on the dead subject; this method may be adopted in almost all operations on the extremities with more or less complete success; in extirpation of tumors, tying of arteries, scraping off of scrofulous ulcers and carious bones, and in resections of smaller bones and joints, the compressing tubing need not be relaxed until the dressing of the wound is completely finished; as in the extremities, so the supply of blood to the male genital organs can be entirely cut off by the In-

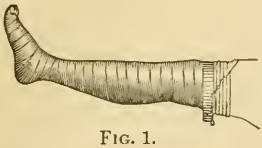


Fig. 1.

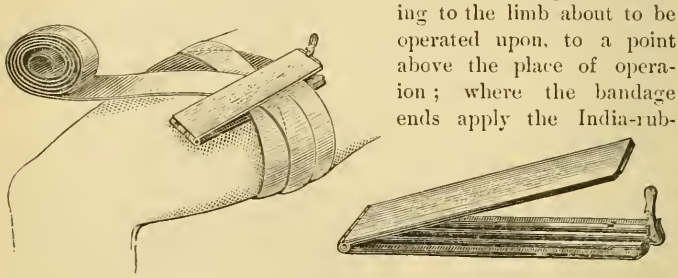


Fig. 2.

[1] F. Esmarch.

dia-rubber tubing; to remove a testicle or amputate the penis, apply a thin India-rubber tubing from behind round the root of the scrotum and penis, cross the ends in front on the mons veneris, and tie them on the loins; the tubing may perhaps be found useful in operations on the trunk, neck, and head, by shutting off the blood of all or some of the extremities, from the general circulation, by strapping, and thus forming reserve stores from which we could admit the blood successively again into the general circulation, if the patient were in danger of bleeding to death; the dangers which may arise from this method are not determined, but we must not ignore the possibility that the firm strapping of a limb for any considerable time may be followed by serious derangements of the circulation and innervation, such as thrombosis, inflammation, paralysis, etc.; when operating upon parts infiltrated with ichorous matters, it would be a wise precaution not to apply the bandage, but to raise the limb, and empty the vessels as completely as possible before applying the tubing.[1]

2. **Elastic rings**[2] of proper size, rolled upwards from the extremity of the limb effectually suppress all circulation. The advantages are complete control of the circulation, and simplicity and facility of application. A set of rings contains nine sizes, the smallest being of solid rubber cord, and one half an inch in diameter, the largest being of rubber tubing, and four and a half inches in diameter. Select a ring suited to the limb to be operated upon, and roll it slowly from the extremity upwards, sufficiently above the point of operation; the rings for the arm and forearm should fit the wrist firmly, and those for the thigh and leg the ankle; in applying the rings, one side may be raised to pass painful or diseased parts, or the ring may be stretched and placed above the seat of injury or disease, thereby avoiding the forcing of septic fluids into the circulation.

Fig. 3.

II. ARTERIAL COMPRESSION.

The control of the circulation may be effected by compression of the artery which supplies the part. As this method, however carefully applied, permits of the loss of the blood contained in the limb, the amount should be diminished, as far as possible, by elevating the limb, and rubbing towards the heart.

[1] F. Esmarch. [2] A. E. Spohn.

1. **The Fingers** afford ready and available means of arterial compression when the artery is accessible, and lies upon a bone. (Fig. 3.) If the thumb is used, it must be laid flat upon the vessel; in either case the pressure must not be relaxed; if the vessel slips from the grasp it should be instantly compressed again upon the bone by the fingers or thumb, but not by grasping the limb; the fingers are best employed in compression of the brachial, the radial, and the ulnar arteries; the thumb in compressing the abdominal

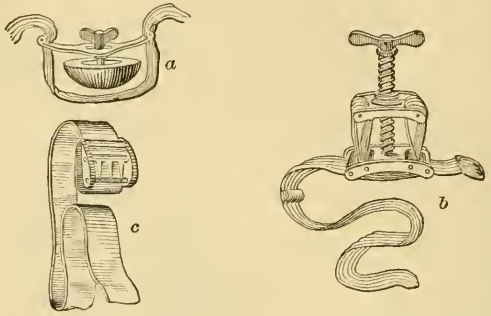


FIG. 4.

against the vertebræ, the external iliac against the brim of the pelvis, the femoral against the pubes, or in the upper part of the thigh.

2. **The key**, the ring being so padded as to make a hard mass, is used to compress deep-seated arteries, as the subclavian.

3. **The tourniquet** has several modifications (Fig. 4, *a*, *b*, *c*), but the most important difference is in the effect upon the venous circulation; they may compress the limb only at opposite points (*a*); or the entire limb, the pad being placed over the artery (*b*, *c*). The most useful instrument is that in common use (*b*)[1]. In its application it is usual to put several turns of a roller around the limb at the point where it is applied, terminating with placing the cylinder of the roller over the artery as a compress; the tourniquet should now be applied, but the screw should not be placed over the cylinder, lest the ball roll from the artery when the screw is

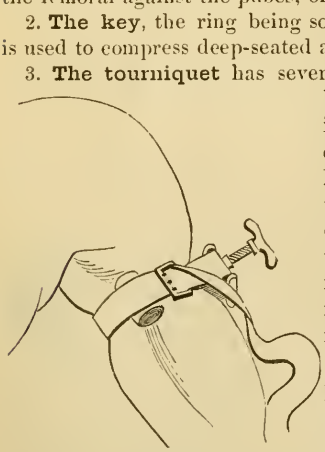


FIG. 5.

[1] J. L. Petit.

worked. The screw being placed at one side of the limb (Fig. 5), the strap should be buckled tightly, and the screw gradually turned to the necessary tightness; if there is a liability of the slipping of the compress, put the cylinder of the roller between the pad and the strap, and apply it to the artery. The tourniquet may be specially adapted to compress the abdominal aorta,[1] or it may be devised to compress either the femoral, the aorta, or other large arteries.

4. **The ligature** is sometimes usefully applied to the main artery of the limb or part to be operated, as to the common carotid artery in operations on the face and mouth.[2]

III. LIGATION.

The application of the ligature to cut vessels is the favorite method of controlling bleeding during and after the operation. The material employed may be irritating or non-irritating; the former induces suppuration, and must be removed from the wound when the vessel is closed; the latter causes no suppuration, and may be inclosed in the wound. In applying the ligature the coats of the artery should, as far as possible, be isolated from surrounding tissues with the tenaculum (Fig. 6), or the tenaculum forceps (Fig. 7), or the dog-tooth forceps. Draw the artery well out, and press the knot down with the index fingers (Fig. 9); to apply the ligature accurately the forceps should have a slide (Fig. 8) which, drawn up while the ligature is cast around the points of the forceps, may then be forced down, and will carry the ligature directly upon the artery as the first knot is being tightened. If necessary, seize several bleeding vessels before the ligatures are applied to restrain immediate hæmorrhage, as when assistants are not at hand, and employ any form of catch or claw forceps that may be at hand. (Fig. 10.)

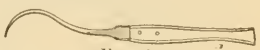


Fig. 6.

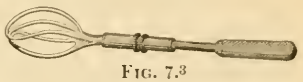


Fig. 7.[3]

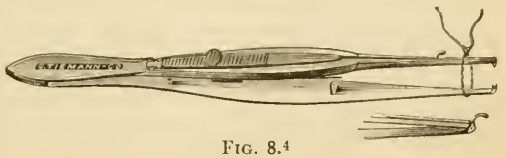


Fig. 8.[4]

Fig. 9.

1. **The silk ligature**, though irritating, is still generally preferred. It should have three threads and be so firm as to resist the utmost strain of the fingers. In its application make the surgeon's knot

[1] J. E. Erichsen; J. Lister. [2] V. Mott. [3] D. Prince. [4] H. J. Bigelow.

(Fig. 11) or the sailor's knot (Fig. 12). To tie the latter knot, hold the ligature between the thumb and finger of the right hand; throw the end round the forceps, and seize the body of the ligature between the middle and ring finger of the left hand, in a prone position, the end being grasped between the thumb and index finger; draw the thread

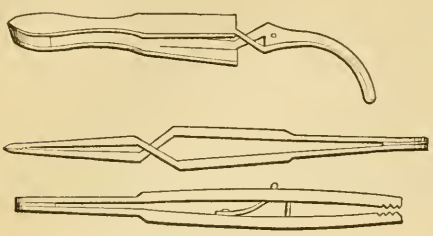


Fig. 10.

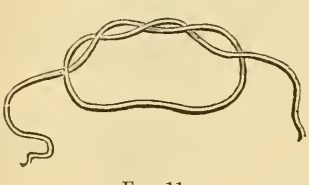


Fig. 11.

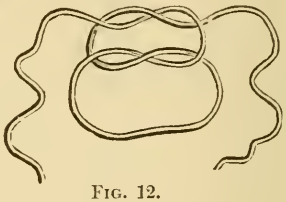


Fig. 12.

in the right hand over the end of the left index finger and the extremity of the ligature, and pass it between the ends of the index and middle fingers; now taking the end of the ligature from the grasp of the left index finger and thumb with the right index finger and thumb, the knot is completed by drawing out the portion passed between the left index and middle finger; in tying the second knot the action of the hands must be reversed. Cut one end near the knot and draw the other out of the most depending part of the wound. In some cases the bleeding vessels can not be isolated, and it becomes necessary to enclose a small area with a ligature (Fig. 13) passed around it with a needle.

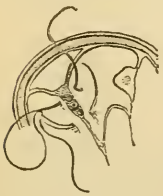


Fig. 13.

2. **The hemp ligature** differs from the silk only in its want of pliability, being much more inflexible.

3. **The catgut**, carbolized, is a non-irritating ligature, and seems to fulfill all the conditions of a perfect hæmostatic, combining the security and universal applicability of the ligature with the absence of a foreign body in the wound.[1] After the knot is tied, both ends of the ligature should be cut off and the wound permanently closed.

IV. TORSION.

The twisting of an artery upon its axis is designed to cause laceration of the internal coats of an artery; they then roll into the calibre

[1] J. Lister.

of the vessel and form a mesh, within which a blood clot forms and becomes organized; the external twisted coat remains as a protection and support. Torsion is a reliable method,[1] especially when applied to small arteries, but is not generally approved for large arteries.

1. **Free torsion** is applicable to small arteries, and consists in seizing the extremity of the vessel with firmly united forceps, drawing it out from its connections, and rotating it several times.

2. **Limited torsion** is applied to large arteries, as follows: —

Seize the extremity of the artery with strong catch forceps, having blunt serrations; draw it well out of its sheath; grasp it firmly with a second forceps about one inch from the end; now rotate the first forceps three or four times, or until all resistance ceases. (Fig. 14.)

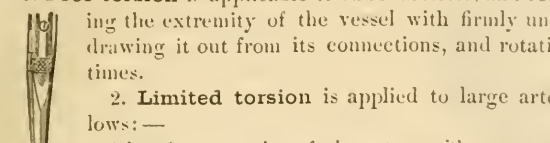


Fig. 14.

V. ACUPRESSURE.[2]

Compression of the artery in the wound by means of a needle is reliable in the arrest of bleeding,[3] prevents secondary hæmorrhage even when the condition of the blood or artery predisposes to such accidents, is adapted to cases in which the artery cannot be seized or is friable, admits of the ready closure at the same time of the veins, and protects the interior of the wound from foreign matters on withdrawal of the needles in twenty four to forty-eight hours.[4] The instruments required are bayonet-pointed pins, varying in length from three to five inches, with glass heads to facilitate their introduction, needles threaded with iron wire, and loops of slender annealed iron wire, five or six inches in length. On the cut surface of a flap the ordinary sewing needle answers perfectly well. There are several methods of employing the pins to accomplish compression, but they may be reduced to three.

1. **Direct compression** (Fig. 15) is made by the pin thrust through the flap, passed over the artery, and brought out of the integument of the opposite side, in such manner as to firmly compress the mouth of the artery against the muscle upon which it lies.

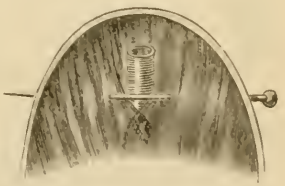


Fig. 15.

2. **Compression with wire** is effected by passing the point of the pin under the vessel, then casting over it and in front of the artery a loop of wire which is tightly fastened to the shaft of the pin; the pin is then passed through the opposite flap.

[1] T. Bryant. [2] J. Y. Simpson. [3] T. Holmes. [4] J. C. Hutchison.

3. **Compression by torsion** (Fig. 16) is made by transfixing the wound by a pin an inch or more, A, on the side of the artery, then carrying it half way around the face of the stump or wound to B, and thrusting it into the tissues beyond.

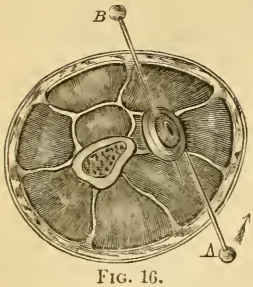


Fig. 16.

The time for the removal of the pins or needles should not exceed forty-eight hours for the larger and twenty-four hours for the smaller arteries, and even a much less period has been found to suffice.[1]

VI. CONSTRICTION.[2]

This method of arresting hæmorrhage requires the rupture of the internal and middle coats of the artery by means of a constrictor; the ruptured coats contract, retract, and curl up (Fig. 17); the external coat is drawn over and firmly compressed, causing invagination of the internal coats; an internal coagulum now forms, while the integrity of the external coat and the continuity of the vessel are preserved (Fig. 18). The advantages of this method are that it is efficient, safe, and easily applied; no internal coagulum is necessary, as the invagination of the internal and middle coats is sufficient to arrest hæmorrhage; no foreign body is left in the wound; there is no risk of secondary hæmorrhage, pyæmia, or phlebitis; it is applicable to all sizes and conditions of arteries where the external coat is perfect; it has a uniform effect, and requires but little skill or practice in its application, and the management of details.

Fig. 17.

Fig. 18.

The instrument consists of a flattened metal tube, six inches (more or less) in length, open at both ends, with a sliding steel tongue running its entire length, and having a vice arrangement at the upper extremity, by which it can be made to protrude from or retract within the tube or sheath; the lower end of the tongue is hook-shaped, so as to be adapted to the artery to be constricted; it is so shaped that having grasped an artery, it can be made to contract upon it by means of the vice at the upper end, which forces it within the sheath (Fig. 19); the hook of the tongue is so shaped and grooved as to form only

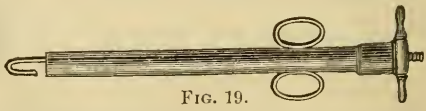


Fig. 19.

[1] G. A. Peters. [2] S. F. Speer.

a compressing surface, by which means the artery, when acted upon by the force of the vice, is compelled to assume the form of the curve of the tongue, and the artery is constricted in such a way that its internal and middle coats give way, but the external coat is preserved intact.

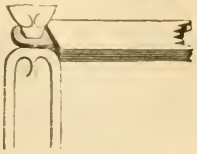


Fig. 20.

It is applied as follows: Seize the artery with a tenaculum, or forceps; pass the tongue of the constrictor around the vessel and draw it tightly upon the artery by means of the vice arrangement at the end (Fig. 20); when the screw turns with considerable resistance, or the internal coats are seen to be invaginated by noticing their movements in the end of the artery, detach the tongue, and the operation is completed.

VII. AERTIVERSION.[1]

This method is designed to reinforce the cut extremity of the artery by duplicature of its walls, and thus secure such an amount of muscular structure around the cut end as will effectually close its calibre against the impulse of the heart's action.

The advantage of the method is, that it leaves nothing but living tissues in the wound. There is a tendency, by the alternating distention and contraction of the vessel, to force the reflections back.

The operation is readily made with an instrument (Fig. 21) hav-

Fig. 21.

ing a tenaculum point; this is easily introduced within the artery, and holding the margin with the forceps, traction on the hook inverts the coats, as the cuff of a sleeve is rolled backward.

VIII. CAUTERIZATION.

The cautery, once the only method of arresting bleeding after operations, is now required only when deep seated parts are involved, or tissues to which the ligature cannot safely be applied.

1. **The actual cautery** consists of an iron or steel knob, at the extremity of a long shaft, secured to a handle. The shape of the extremity may be round, or pear-shaped, or flat like a button; each form is adapted to special conditions requiring its use. It may be heated in the flame of a spirit lamp; when em-

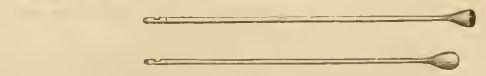


Fig. 22.

[1] G. C. E. Weber.

ployed to arrest hæmorrhage its temperature should be at a dull red heat.

2. **The thermo-cautery**[1] (Fig. 23) is a very ingenious instru-

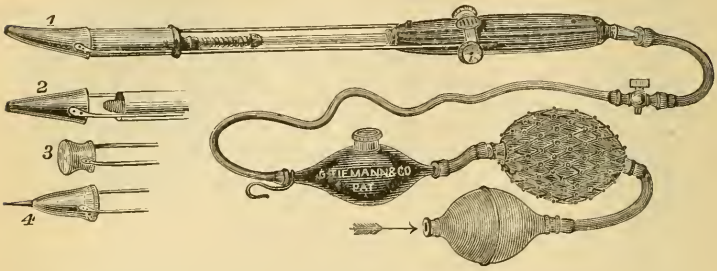


Fig. 23.[2]

ment by which a high degree of heat of the cautery may almost instantly be obtained, and may be maintained for any length of time without the slightest inconvenience. It is peculiarly useful in operative procedures in the mouth, vagina, and rectum. By adapting a blade to it, dissections may be made, and with the wire ecraseur, tumors may be removed in a bloodless manner.

The hard rubber receiver, to which the hook is attached, is filled with wool. By removing the screw button, only a sufficient quantity of benzine or gasoline is poured in to saturate the wool ; with the hook the receiver may be attached to a button hole. By compressing the rubber bulb, the air passes into the thin rubber bag covered with netting, for the purpose of causing a continued stream of air. The air being saturated by its passage through the hard rubber receiver, is forced through the instrument into the platina point No. 1, having passed through the platina coil upon the end of the tube. The instrument may be ignited by a match, and the white or dull red heat required upon the platina points is regulated by drawing down the platina cone upon the cylinder, which, being attached to a spiral spring, yields to the pressure of the thumb. The stop-cock regulates the volume of air to be passed. Various platina points, knife-shaped, flat, and needle pointed, are easily attached.

CHAPTER V.

THE ANÆSTHESIA.

Anæsthesia is the first recognized stage in all operations, and the surgeon is held strictly responsible for the selection and administration of the proper agent.[3] He may also be charged with improper conduct by female patients to whom he has administered an

[1] M. Paquelin. [2] Tiemann & Co. [3] Bogle *v.* Winslow.

anæsthetic.[1] Protection from the charge of negligence is found in strict conformity with the established rules of administration,[2] and from the charge of immoral conduct by the presence of a third party.

I. GENERAL ANÆSTHESIA.

Anæsthesia [3] may be partial, full, profound, or fatal, with no distinct boundary lines between the degrees. The two intermediate degrees constitute anæsthesia proper, the first of which is desired in surgery; to produce and maintain this stage of narcosis with safety is a delicate application of means to an end; the exact relation of the thing to be done, and the power applied to do it, involves the whole question of selecting an anæsthetic, and forbids the arbitrary or exclusive use of either of the well-known employed agents. The agents which have been well tried up to the present time are nitrous oxide, ether, and chloroform; with proper discrimination in applying each of these to its appropriate uses only, and proper skill in their employment, all of the legitimate purposes of anæsthesia can be accomplished with reasonable safety.

1. **Nitrous oxide** [3] is noticeable for the certainty of its effects, the prompt recovery of patients, and its safety. It is best adapted to the momentary operations of minor surgery, because, to produce complete anæsthesia, it must be inhaled nearly or quite pure, which entirely deprives the blood in the lungs of the supply of air.[3] An average of about seven gallons of gas is required for complete anæsthesia, and from one to two minutes to produce the desired effect. The anæsthesia is of about one to one and a half minutes in duration, and passes off almost entirely in three or four minutes.

2. **Sulphuric Ether** [3] is a safe and reliable anæsthetic; when it is slow in its operation, or has a long and troublesome stage of excitement, or fails to produce sufficient anæsthesia unless an excessive amount is administered, there is mismanagement in its use. Its efficiency depends upon the degree of concentration in its administration; hence the necessity of using such an appliance as will supply the ether vapor to the patient in a concentrated form. The simple cone of towels will answer, but an apparatus, suitably prepared, is preferable.

Select a stiff towel,[4] properly folded; it should be a new one, of pretty good size, taken just as it comes from the laundry; unfold no further than to display it in the dimensions of about ten inches by five; fold down two of the corners in such a way that they shall lap over each other a little, and secure them by stout pins; a cone will thus be made which fits the face admirably; the thick layers of towelling will hold sufficient ether, and its texture will prevent a too free dilution of the anæsthetic by the atmospheric air, provided the apex and seam

[1] —— *v.* Beale. [2] Bogle *v.* Winslow. [3] E. R. Squibb.
[4] Committee of Boston Society for Medical Improvement.

of the cone are carefully and tightly closed, either by pins or the fingers; as the cone becomes collapsed by saturation, it should from time to time be opened, and kept in shape by distending it with the hand; unless these details are attended to, and especially the closure of the apex of the cone, the induction of anæsthesia will be uncertain and protracted; in anything so porous as a towel or sponge, the difficulty is to exclude enough air. A simple, effective, and inexpensive apparatus[1] (Fig. 24) may be obtained, which consists of a wire frame-work, sufficiently large to cover the lower part of the face; the wires are parallel, and about an eighth of an inch apart; between the wires, from side to side, a strip of bandage two and one-half inches wide is passed; the instrument is about four inches long, and three inches at its greatest width, and yet it consumes more than three yards of bandage when passed between all the wires; each section of the bandage is separate from the adjoining one, thus permitting the air to pass freely to both sides of it; over this frame is drawn a piece of stout sheet India-rubber, or patent leather, which has been stitched together at the edges, so as to make a covering for the frame, projecting over one end two inches, to form the mask, and at the other one inch. The ether is poured on the bandage, which forms a close, well-made artificial sponge; the instrument is especially serviceable when a prolonged use of ether is required.

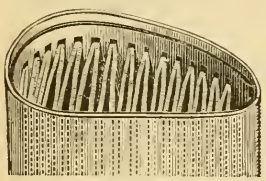


FIG. 24.

The cone or apparatus having been properly prepared, proceed as follows:[2] First give the patient, fasting, about fifteen minutes before the time set for operation, a fluidounce or a fluidounce and a half of brandy or whiskey, if an adult male, or two fluidounces of wine if a female; this produces slight intoxication in about ten minutes, shortens the stage of excitement in many cases, and renders retching less likely to occur; the patient is then placed quietly on the table, and is advised in a low, quiet tone, to be composed and perfectly still; about ten minutes before the time for operation, the patient is required to smell the ether strongly at each inspiration, for the purpose of getting used to it; this establishes tolerance or partial anæsthesia of the mucous membrane of the air-passages, and thus avoids some of the coughing and strangling; the quantity of ether for the first charge should vary with the estimated sensibility of the patient. For an adult man, one and a half to two fluidounces, and for females and sensitive males one to one and a half fluidounces is sufficient, if the ether be good; for children, a half to one fluidounce. The most convenient place for the manipulator is at the head of the table, whence he can best apply a hand to either side of the patient's face, and thus support the cone in position without much pressure; the thumbs naturally fall into the fossæ on each side of the nose, while the fingers support the part under the chin, care being taken not to press upon the larynx; if the patient has a beard, it

[1] C. N. Allis. [2] E. R. Squibb.

should be wetted to render it less pervious to air; if, after a few inspirations of the concentrated vapor, respiration is suspended, remove the apparatus, but as soon as respiration is reëstablished, replace it over the nose and mouth; if restless excitement occurs, avoid obstruction to the mouth and nose, but under no circumstances allow the apparatus to drop off during the excited movements; if retching occur, continue the ether, but if actual vomiting is imminent, remove it momentarily. The patient soon passes into the third or required stage of narcosis, often with a shudder, or slight general convulsion. Watch the pulse, respiration, and color of the surface throughout, and test the eye or the roots of the nails from time to time to ascertain the condition as to insensibility; as soon as this is fairly established, begin the operation. In a large proportion of cases not more than four of the eight minutes will have been consumed. When the operation is fairly under way, and no sensibility shown, remove the ether to avoid the fourth, or snoring stage of narcosis, and replace it when signs of sensibility are seen.

3. **Chloroform**[1] is the most rapid, certain, and effective anæsthetic; the facility and simplicity of its administration, the small quantity required, the certainty of good quality, its non-inflammability, its cheapness, its agreeable odor, combine to render its use popular; but, unfortunately, sudden and overwhelming paralysis of the heart, commonly called cardiac syncope, which is beyond human skill and knowledge to foresee or prevent, occasionally causes death by it. Hence, great care is necessary in the use of chloroform, when organic disease of the heart is present; but, though patients with very weak, fatty hearts are in somewhat greater danger from chloroform than other persons, yet, when cautiously given, they may take it safely, and in valvular disease the risk of chloroform would be less than that of the pain and alarm attending any considerable operation without it.[2] The administration should be by an experienced assistant. Preparatory to taking chloroform[3] the patient should be directed to omit the last meal which would naturally precede it, and to loose any tight band around the neck and waist; arrange a common towel so as to form a square cloth of six folds; pour upon it enough chloroform to moisten a surface in the middle about as large as the palm of the hand, the precise quantity used being a matter of no consequence; hold the cloth as near the face as can be comfortably borne, more chloroform being added occasionally as may be necessary; continue the administration until the eyelids cease to move when the conjunctiva is touched with the finger; meanwhile watch the breathing carefully, and if at any time it become obstructed or strongly stertorous, remove the cloth and draw the tip of the tongue firmly forwards till the tendency to obstruction has disappeared.

[1] E. R. Squibb. [2] Sir J. Paget. [3] J. Lister.

4. **Rapid respiration**[1] will induce a sufficient degree of anæsthesia to admit of slight operations without pain, as the passage of a probe into wounds, or manipulation of injured limbs and inflamed parts. The patient must be required to breathe rapidly for about three minutes, when there will be tingling of the surface, especially of the fingers, a feeling as if the surface were swelling, dizziness or confusion in the head, without obliteration of consciousness.[2]

II. LOCAL ANÆSTHESIA.

In trivial operations involving slight incisions, as opening abscesses, local anæsthesia is preferred. It consists in benumbing the surface with cold, or an anæsthetic.[3]

1. **Ice** is applied as follows: pulverize finely and mix with half its bulk of salt; apply the mass in a gauze net or an India-rubber bag; continue its application only until the surface is pale, bloodless, and insensible; if continued too long, a frost bite or chilblain will follow.

2. **Ether** in the form of spray is a very efficient and simple method of relieving a part of sensibility. For this purpose a spray-producing apparatus is required.

The most efficient anæsthetic refrigerator[4] has a continuous jet and consists of a bottle for ether and a bellows with a reservoir; put the ether in the bottle, nearly filling it, then insert the tube with the cork firmly, and fit the nozzle to give the jet desired. Grasp the bulb on the extremity of the rubber tubing and use it as a hand-bellows, the other bulb acting as a reservoir; the small wires, stylets, are used to graduate the spray, which is made finer or heavier by the use of different sizes; remove the nozzle and insert the stylet in the small tube. A very efficient refrigerator, with continuous jet, may have the bottle as the reservoir (Fig. 25).

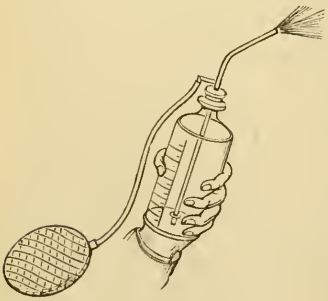


FIG. 25.[5]

3. **Liquefied carbolic acid**,[6] retained in contact with the skin for two or three minutes, causes a white spot, which is soon surrounded by a congested circle; serum is next effused, which raises the skin in a wheal; the smarting or pain now subsides and anæsthesia begins in the white part, while the congested part becomes hyperæsthetic; the anæsthesia is at its height in fifteen or twenty minutes, and involves the skin down to the cellular tissue; the affected tissues

[1] W. G. A. Bonwill. [2] A. HEWSON. [3] J. Arnott. [4] B. W. Richardson.
[5] G. Tiemann & Co. [6] J. H. Bill.

may be punctured, cut, or burned without sensation; soaking the parts with dilute acetic acid increases the effect of the carbolic acid; wounds made in tissues thus treated heal rapidly.

CHAPTER VI.

THE OPERATION.

THE manual part of the operation may be one step in the treatment of a disease, or it may comprise the entire responsibility of the surgeon, as in cases where he is required only to operate. The result may depend upon other conditions than the operation, or upon the operation alone; in either case he is required to bring to the discharge of his duties the skill requisite to properly accomplish the object.[1] The plan of the operation should, when practicable, be carefully matured, and, if it is difficult or complex, be practiced on the subject frequently before the time fixed.[2] Regard must be had for established methods in similar conditions, for the surgeon will be responsible for any unfavorable results following a departure from the ordinary and approved rules.

I. INSTRUMENTS.

All operations require the knife, the forceps, and the director; for special operations, special intruments are necessary.

1. **The knife** may be in the form of a scalpel or bistoury; the scalpel is of several sizes, and the blade varies in breadth, the broad blade being adapted to large and deep incisions, the narrow to more delicate dissections; the bistoury varies much in the shape of the blade, being curved or straight, sharp or probe pointed, broad or narrow, and with full or partial cutting edge.

2. **The forceps** should have serrated claws and a spring so firm that the extremities hold firmly under strong pressure; the common dissecting forceps loose their hold when the limbs are pressed together, and thus render dissection tedious and embarrassing.

3. **The director,** being used to raise thin tissues, as fascia, for incision, should have a deep groove terminating in a slight cul-de-sac to prevent the escape of the point of the knife.

II. DISSECTION.

The process of exposing deep-seated parts is the dissection. The practiced operator[3] familiar with the use of his knife, and confident in himself, divides boldly and freely, his progress is clearer at every incision, his work is systematic, he proceeds slowly and steadily,

[1] J. Ordronaux. [2] V. Mott. [3] F. C. Skey.

every cut tells, and every movement has a meaning and an object; but timidity marks the ignorant man at every step, and uncertainty and indecision characterize his movements; he passes from one part of the wound to another without any rational object or intention, dissecting a little here and dividing a little there, but completing nothing; finding his own resources fail, he lends an ear to the suggestion of one and another, and adopting imperfectly the advice of each, protracts the operation three or four times the necessary period.

1. **The hand**[1] best adapted to make the dissection is the right; it will be of advantage to dissect occasionally with the left, but there are few who will attain the same command over it as over the right hand; besides the left always has important duties to perform and may be said to be the servant of the right.

2. **The position**[1] in which the knife is held varies with the kind of incision to be made; the most general position is nearly identical with that of a pencil or pen when held in the act of writing (Fig. 26), the thumb being applied on one surface of the handle, the index finger on the back, and the middle placed partially behind to regulate somewhat the force employed by the index, and the little finger resting on the body; this position is adapted to cutaneous incisions requiring caution in the degree of pressure, as in an operation for hernia, aneurism. For great delicacy and convenience of manipulation the knife is held like the violin bow (Fig. 27), the thumb antagonizing all the fingers. This position enables the operator to make a transverse incision. By turning the knife, held in either of these positions, upon its axis, other positions are assumed, the first adapted to opening abscesses, and the second to slitting tissues. The bistoury, straight and pointed, may be held in either of these positions, but it is more frequently held as a pen (Fig. 28), in the opening of abscesses, and in the second position in dividing fascia or parts concealed from view, when for safety its point is carried along a grooved director (Fig. 29).

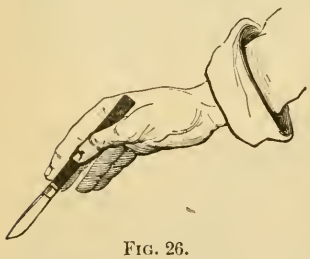


Fig. 26.

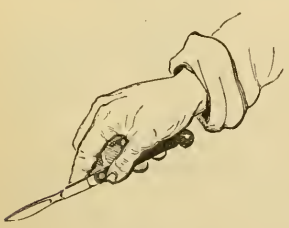


Fig. 27.

3. **The manipulation**[1] of the knife in dividing parts, whatever may

[1] Sir W. Fergusson; R. Liston; V. Mott; F. C. Skey.

be the fineness of its edge, must be on the principle of the saw; art in the use of the knife consists in adapting the requisite force to the surface to be divided, and the less the pressure of the hand, provided the edge be applied like a saw, nearly parallel to the surface

Fig. 28.

Fig. 29.

to be divided, the more perfect will be the wound, and when brought into contact, the more readily will it reunite. In dissections requiring cautious cutting, the knife should be drawn lightly and steadily along the surface with such force that the divided textures fall gently to each side, the pressure being regulated by the nature of the textures to be cut, the proximity of important parts, and the depth of the wound. The bistoury is either carried completely through the soft parts, dividing the fascia or sinus from its remote extremity backwards towards its orifice, or, if probe-pointed, by raising the blade out of the groove, dividing from the orifice to the remote end.[1]

4. **The incision**[1] may take any form adapted to the special operation in hand, being single or compound, straight or curved, from without inwards, or the reverse, but all incisions should, as far as possible, be made in the line of natural folds of the skin, and in the course of vessels, nerves, muscles, and tendons; when two are made in close proximity, the lower should be made first, to avoid the blood. The precise line over which the first incision is to be made must first be determined, and its length should be adapted to all the purposes of the operation, being neither of unnecessary length nor so contracted as to require subsequent enlargement. In making the first cut, render the skin tense over the part without displacing its relations, then

[1] F. C. Skey; Sir W. Fergusson; V. Mott.

thrust the point of the knife into the integument at a right angle with the surface, depress the wrist, and incline the edge upon the skin, make the cut of the requisite length, and elevate the wrist, placing the knife at nearly the same angle as when it was introduced; if the integument is very lax, this incision may be made by pinching up the skin, thrusting the knife through both layers, and cutting outwards. In continuing the dissection, make every movement of the knife advance the operation in an orderly manner. Each incision should so far correspond in extent with the first that the deep tissues are fully exposed; when the handle will separate tissues in the vicinity of vessels, nerves, or cavities, use it in preference to the blade; raise fascia immediately overlying important structures on the director, and then incise, unless perfectly competent to cut them directly without risk. Remove all oozing blood during the operation by absorption from time to time with an aseptic sponge.[1]

5. **The conclusion**[2] of the operation must be perfected in every detail with as much care as the first stages; there is great danger to the patient when the operator, after he has passed through the sort of mental tension in which he performs the most difficult part of what he has to do, and his attention has been completely occupied in some difficult task to be achieved, allows his mind to relax and his attention to be less keen and ready for exercise.

CHAPTER VII.

THE EMERGENCIES.

DURING every stage of an operation there is a liability to sudden and dangerous accidents and complications which demand prompt recognition and energetic treatment. Some of these emergencies result more or less directly from the use of anæsthetics, while others are incident to the operation. A safeguard against the first is the selection of an assistant to administer the anæsthetic who is not liable to have his attention distracted by the operation, is familiar with all the phases of anæsthesia, and is competent to meet every indication of care and treatment.

I. NARCOSIS.

Narcosis by anæsthetics is progressive, and may advance symmetrically or asymmetrically; that is, all the vital functions may be equally and uniformly depressed to obliteration, or the narcotic influence may, in any part of its progress, be concentrated upon some one vital function, or organ, and prove fatal.[3] The most important

[1] J. Lister. [2] Sir J. Paget. [3] E. R. SQUIBB.

symptom to watch is the respiration, for if obstructed breathing continue long it leads to fatal paralysis of the nervous centres.[1] Death may also commence at the heart, and hence the pulse must also be frequently examined.[2]

1. **Slight narcosis**, as irregular respiration, without failure of the pulse, will generally yield to any shock, as a slap on the face with a towel wet in cold water, or forcible compression of the chest, pressure under the ribs of the left side in the direction of the diaphragm, ammonia applied to the nostrils, or nitrite of amyl.[3]

2. **Profound narcosis** is announced by stertor, impeded respiration, pallor, or lividity of face; such symptoms demand immediate treatment. Two methods of resuscitation are strongly recommended, both of which can always be instantly applied. The first [1] is based on the theory that respiration ceases from laryngeal paralysis, which is indicated by stertor, and may be relieved by very forcible withdrawal of the tongue; artery forceps, or a tenaculum, are the best instruments; in order that it may be effectual, firm traction is essential; the end of the organ may be withdrawn considerably beyond the lips without any good effect, but if an additional pull be given, the nervous system is aroused and respiration reëstablished. The second method [4] consists in inversion of the body, with a view to overcome supposed cerebral anæmia, as follows: suspend the body with the head downward by elevating the thighs or hips, or by allowing the body to hang from the side of the table; separate the jaws, and draw the tongue forcibly forward; agitate the body, and practice artificial respiration; persevere in maintaining the patient in this position for thirty minutes or more, if necessary.[5]

3. **Apnœa** from regurgitation of the contents of the stomach into the lungs occasionally occurs,[6] and requires prompt treatment by the direct method [7] of treating persons suffering from drowning.

To relieve the lungs of the fluids, proceed as follows: —

Face downwards; a hard roll of clothing beneath the epigastrium, making that the highest point, the mouth the lowest; forehead resting upon forearm or wrist, keeping mouth from the ground; place the left hand well spread upon base of thorax to left of spine, the right hand upon the spine a little below the left, and over lower part of stomach; throw upon them with a forward motion all the weight and force the age and sex of patient will justify, ending this pressure of two or three seconds with a sharp push, which helps to jerk you back to the upright position. Repeat this two or three times, according to period of submersion and other indications.

Artificial respiration is produced as follows, whenever it is required: Face upwards; the hard roll of clothing beneath thorax, with shoulders slightly de-

[1] J. Lister. [2] T. Holmes. [3] F. A. Burrall. [4] Nélaton: Schuppart. [5] J. M. Sims. [6] Bellevue Hospital Records. [7] B. Howard.

clining over it; head and neck bent back to the utmost. Hands on top of head; (one twist of handkerchief around the crossed wrists will keep them there); rip or strip clothing from waist and neck; kneel astride patient's hips; place your

Fig. 30.

hands upon his chest, so that the ball of each thumb and little finger rests upon the inner margin of the free border of the costal cartilages, the tip of each thumb near or upon the xiphoid cartilage, the fingers fitting into the corresponding intercostal spaces; fix your elbows firmly, making them one with your sides and hips: then —

Pressing upwards and inwards towards the diaphragm, use your knees as a pivot, and throw your weight slowly forwards two or three seconds until your face almost touches that of the patient, ending with a sharp push which helps to jerk you back to your erect kneeling position. Rest three seconds; then repeat this bellows-blowing movement as before, continuing it at the rate of seven to ten times a minute; taking the utmost care, on the occurrence of a natural gasp, gently to aid and deepen it into a longer breath, until respiration becomes natural. When practicable, have the tongue held firmly out of one corner of the mouth with thumb and finger armed with dry cotton rag. Avoid impatient vertical pushes; the force must be upward and inward, increased gradually from zero to the maximum as the age, sex, etc., may indicate. Abandon no case as hopeless within an hour's useless effort.

The following methods may be employed: 1, lay the patient on his back, with the shoulders elevated, draw the tongue forcibly forwards, grasp the arms at the elbow and carry them upwards firmly until they nearly meet above his head, then lower them to the side, and make firm compression upon the lower part of the sternum; repeat this process twelve to fourteen times in the minute.[1] Or 2, turn the body gently and completely, on the side and a little beyond, and then on the face, alternately; repeating these measures deliberately, efficiently, and perseveringly, fifteen times in a minute.[2]

Meantime other measures should not be neglected, as external stimulants, the application of the poles of the battery to the vicinity of the diaphragm in front and the cervical region behind.

[1] Sylvester. [2] M. Hall.

II. BLEEDING.

It not unfrequently happens that profuse bleeding occurs from many vessels, to which the operator cannot apply the ligature without losing valuable time. This complication must be promptly met by compression of the cut vessels by the fingers of an assistant, aided by dry sponges or a towel, to which ice may be added; a skillful assistant may thus cover the exposed vessels of a large surface as the dissection proceeds.[1]

III. SHOCK.

Severe reflex disturbance or paralysis of nerve centres is liable to supervene towards the close of an operation, especially on a sudden loss of blood, when the operator is least prepared to encounter so formidable a complication. In general, it is remarkable how little impression is produced by even the most severe operations,[2] and hence the surprise which the discovery of the presence of shock creates. The patient often passes suddenly from a state of proper anæsthesia, and without any additional anæsthetic, to a condition of more or less profound shock. There is no warning of its approach, and the first impression is that too much of the anæsthetic has been given.[3] This is not narcosis from anæsthesia, but shock. The degree of prostration depends somewhat upon the previous condition of the patient and the nature of the disease, but more markedly upon the degree of shock from the injury which gave rise to the operation, the amount of blood lost, and the length of the operation. The bodily temperature and pulse are the best guides to determine the severity and danger of shock, and ought to be noted, first, before the operation, and second, during and after the operation; variations not accounted for by obvious causes will indicate the effect of the operation, and often give timely warning of impending danger. In an average of cases of operations, recoveries have a fall of temperature of less than one degree, and deaths of more than three degrees; a fall below 97° F. is very critical, but recoveries exceptionally occur.[4]

1. **Syncope** may be regarded and treated as an early stage of collapse. These conditions differ only in degree and duration.[5] In the former the crisis is more rapid and in the latter the effects are more extensive and profound.[6] The symptoms are pallor, sighing respiration, feeble pulse, and other symptoms of great prostration. The indications of treatment are to arouse the nervous system by stimulation: place the head low, apply vapor of ammonia cautiously

[1] J. R. Wood. [2] G. W. Callender. [3] J. Croft.
[4] F. Jourdan. [5] B. Travers. [6] W. S. Savory.

to the nostrils, give brandy by the mouth or rectum, or inject it hypodermically, and apply external warmth and irritants; in extreme cases use electricity; or intravenous injections of milk.[1]

2. **Collapse** may rapidly succeed, with the additional symptoms of cold, clammy moisture of skin, and often distinct drops of sweat upon the brow, shrunken and contracted features, reduced bodily temperature, almost imperceptible and often irregular pulse, short and feeble or panting respiration. The treatment of collapse may require, in addition to the measures employed in syncope, transfusion if there has been great loss of blood. As the most unfavorable cases will frequently recover if energetically treated, the efforts at restoration should not be relaxed until recovery is secure, or death has occurred. If reaction begin, stimulation should in part give place to nutrition; the patient must remain in the horizontal position; beef-juice, with brandy, should be given at first, and milk should soon be added; sub-cutaneous injections of morphia are very important in securing rest and quiet; or if it cannot be taken, hyoscyamus may be combined or substituted.

IV. AIR IN THE VEINS.

A wound of a vein is liable to admit air to the circulation; it occurs during dissection in the vicinity of large veins, as in the neck or axilla; the vein having been wounded, slight traction of parts during inspiration allows the air to enter the current of blood. Sooner or later it arrives at the right side of the heart, passes the valves, enters the ventricle, and remains there, dilating by its elasticity the ventricular walls; this distention may take place slowly, but it is constant, often doubling or tripling the normal size of the right heart; from this distention it results that (1) the contractile force remaining the same, and the resistance augmenting, the auriculo-ventricular contraction becomes more and more incomplete; (2) the walls contracting on a gas instead of a liquid compress it without driving it out; (3) the orifices of the right side remaining patulous, the foaming mixture of blood and air regurgitates into the veins and is carried to the most distant parts of the system; this reverse current persists until the distention passes certain limits, when death results.[2] The symptoms are a peculiar sound at the bottom of the wound like gurgling, hissing, or bubbling; a slight issue of venous blood, and often bubbles of air; the patient suddenly turns pale, utters a cry, and becomes insensible, or there is anxiety of countenance, labored respiration, lividity of lips, dilated pupils, and convulsions; syncope is often the predominant feature,

[1] See Veins.

[2] M. Couty.

and the patient may die with scarcely a struggle. The symptoms are developed according to the following conditions: (1) diminution of the aortic contents and loss of arterial tension, with acceleration of the heart, but no general symptoms; (2) more considerable loss of tension and accelerated respiration, with syncope, paleness, dilatation of pupils; (3) Aortic current little or nothing, and excitation of the motor centres, with convulsive movements of the voluntary muscles, involuntary defecation and micturition, respiration slow, deep, apoplectic; (4) no arterial tension, death of the brain, with cessation of convulsions, then arrest of respiration, and, finally, stoppage of the heart's action.[1] The treatment must be prompt and persistent, in the following order: (1) prevent ingress of air by instantly pressing the point of the index finger upon the spot whence the sound proceeds; tie the vein at once, or finish the operation without removing the finger, or while firm compression is made on the vein on the proximal side of the wound; (2) remove the air already admitted by artificial respiration; (3) sustain the vital organs as in profound syncope, by chafing the limbs, applying ammonia to the nostrils, injections of brandy hypodermically or by the rectum, and the employment of galvanism.

CHAPTER VIII.

THE DRESSING.

It is not always possible to secure the repair of wounds by the best method of healing, yet the surgeon is culpable who does not make all needful efforts to obtain in each case the best attainable results. One of the most important factors in the successful healing of a wound is the management of the dressings, but in order to their proper employment the condition of the cut surfaces and the primary stages of repair must be understood.

I. PRINCIPLES OF DRESSING.[2]

Mechanical irritation resulting from the passage of the instruments through the parts appears to throw a thin layer of the tissues at the cut surface into a condition of suspended vital activity, in which, the normal relations between the blood and the living solids being interrupted, the minute vessels become clogged with the blood corpuscles, and coagulable plasma is forced through their parietes and flows out upon the surface of the wound; the fibrine of the coagulating plasma forms the lymph which encrusts the cut surface, while its other and

[1] J. S. Greene. [2] J. Lister.

far larger constituent, the serum, trickling away between the lips of the wound, shows itself as the discharge which soaks the dressings during the first twenty-four hours; the original source of irritation being no longer in operation, the tissues, if free from any disturbing cause, are gradually recovering their powers by virtue of their inherent vital energy, and as they regain their functions the effusion of plasma ceases, and a process of active organization is instituted, by which the lymph is differently affected according to circumstances. If the surfaces of the wound are in juxtaposition, the lymph glues them together, and, being surrounded on all sides by healthy tissue, becomes developed in a few days into a vascular structure which constitutes a permanent bond of union between them; but if the surfaces are separated by serum, pent up in the interior, immediate union is prevented, and the serum, putrefying through atmospheric influence, irritates the tissues and gives rise to suppuration; or if serum be not retained but some persistent local irritation be present, such as the dragging of stitches upon an insufficient covering of soft parts, or a tightly constricting bandage, inflammation will be induced, and in proportion to its degree will interfere with the process of organic development, and convert what promised primary union into suppuration; or if more severe, render the lips of the wound entirely inactive and incapable of producing even pus; or, if still more intense, deprive them of their vitality and cause sloughing; thus while the effusion of the lymph which is the medium of primary union depends upon a species of traumatic inflammation, the healthy organization of that lymph requires the absence of any inflammation whatever, and the great object of treatment must be to place the wound in such circumstances that the tissues may be left undisturbed to recover from the shock they have sustained, and then exert their powers upon the product of their derangement. The following simple rule is of universal application, namely: Let the dressing be destitute of any irritating quality, and so arranged that the surfaces of the wound may be kept in gentle apposition throughout if closed, and free from all irritants if open, while free escape of discharge is maintained.

II. PREPARATION OF WOUND.

To secure the conditions favorable for healing, it is necessary to remove every source of contamination from the wound, and then protect it from all unfavorable influences.

1. **The cleansing** must be effected by such means as will relieve the wound of every particle of foreign matter and shred of dead tissue, and render inert or innocuous any putrefactive organisms which may still adhere to the surface, but great care must be exercised in order not to injure the sensitive tissues in this act. Cleansing and disin-

fection may usually be most readily and thoroughly accomplished by solutions of carbolic acid, 1 in 20, applied by irrigation with the siphon or with the syringe.

2. **The drainage** of a wound is next in importance to the avoidance of putrefaction, for if the effused plasma is allowed to accumulate it is likely to create inflammation by its tension, and also to undergo putrefactive changes.[1] The materials used for drains must be of an unirritating quality, and be rendered aseptic by carbolic acid before their introduction. The caoutchouc tube[2] is useful where it is not liable to such compression as to close its calibre; select a tube of the proper size, and cut it of the requisite length, also cut, with scissors, several holes along its sides to allow the free escape of the fluid into its interior, attach a string to its external extremity, dip it in carbolic acid solution, 1 to 20, and insert it to the bottom of the wound; remove it from time to time, cleanse, disinfect, and re-introduce. Catgut[3] drains well and is finally absorbed, rendering frequent removal unnecessary, but may swell too much, and become so incorporated with the tissues as to cause bleeding, if removed.[1] Horse-hair[4] makes a cheap and efficient drain, and has the great advantage that it can be reduced in bulk at any time without disturbance, by drawing out as many hairs as may be desired; the hair should be treated with carbolic-acid solution, 1 to 20, and may be introduced with forceps, or with the eye of a probe; it may be removed in whole or in part by withdrawing one hair after another; if it is necessary to re-introduce the drain, take a wisp of hair half the size required, bend it in the middle at a sharp angle over the probe, tie a piece of carbolized silk around it close to the probe, on withdrawal of which the drain is left with a rounded end which passes readily into the interior of the wound.[1]

3. **The position** of the wound must be such as to favor the escape of all secretions, to promote the free circulation of blood, and to relieve the wound of all sources of irritation. The wound will thus be so placed as to secure perfect rest, the necessary antecedent to the healthy accomplishment of both repair and growth.[5]

III. ANTISEPTIC DRESSING.

This method is designed to exclude from wounds all putrefactive organisms.[1] Though the antiseptic treatment of surgical diseases is infinite in variety, extending from the simple protection of wounds from contact of catalytic germs, to the purification of hospital wards, water-closets, and grounds,[6] but two principal methods of employing antiseptic dressings are in use; first, by disinfecting the wound and

[1] J. Lister. [2] E. Chassaignac. [3] J. Chiene. [4] L. W. Marshall
[5] J. Hilton. [6] J. H. Hodgen.

the air about the wound with antiseptic agents; second, by intercepting septic matters around an already disinfected wound. The antiseptic agents are very numerous, embracing the haloid salts, the tar creosotes, the antiperiodics, yet they are not all equally applicable for general use.

1. **Carbolic acid**[1] has proved, thus far, the most available antiseptic agent, as it may at once be used for disinfecting the wound and the air, and for storage in the dressings. Though useful, however superficially but judiciously used, its full benefit is secured only when it is employed in a systematic manner, with an intelligent appreciation of the objects sought to be accomplished at each step in the dressing. The following are the details when the dressing is applied according to the formula: Provide a vessel containing carbolic acid dissolved in water, 1 to 40, for the immersion of the hands of the operator, the sponges and instruments used in the wound; a steam spray apparatus, capable of giving a cloud of vapor (make the solution of carbolic acid to be atomized 1 to 30, which diluted by the steam will give a 1 to 40 spray); antiseptic gauze, open cotton cloth impregnated with carbolic acid 1 part, common resin 5 parts, and paraffine 7 parts; Mackintosh (fine cotton hat lining), or gutta percha tissue of good quality will also answer, but is liable to wear into holes; drainage tubes (India rubber, with a silk ligature attached, or horse-hair;) oiled silk protective (oiled silk coated on both sides with copal varnish, and afterward brushed over with dextrine; when the copal varnish has dried, a mixture of one part of dextrine, two parts of starch, and sixteen parts of carbolic acid is brushed over; the acid soon evaporates; common oiled silk, smeared with the oily solution, will answer the purpose pretty well, especially if used in two layers;) carbolized catgut ligatures. Proceed as follows: Shave the part, if there is much hair, in order that the antiseptic may not be prevented from acting upon the skin; wash the part with a watery solution, 1 to 20, to purify the skin; direct the spray upon the part and maintain its action and position during the entire operation and dressing, without a moment's interval; immerse the hands, instruments, and sponges in the 1 to 20 solution before operating, and at every interval when not enveloped by the spray in the 1 to 40 solution; tie all vessels with antiseptic catgut and cut the ligatures at the knot; if the finger is to be introduced into the wound, take special care that it is an aseptic finger, and this is done by cleansing it with an antiseptic solution, making sure that it passes well into the folds about the nail; instruments must remain in the antiseptic lotion sufficiently long to penetrate any dirt or grease which may be concealed on them, as between the teeth of forceps; sponges, though used in suppurating wounds, but thoroughly treated

[1] J. Lister.

with carbolic acid solution, are antiseptically clean. First, wash the cut surface thoroughly with a strong watery solution, 1 to 20; place the drainage tube or tubes so deeply in the wounds as to drain all accumulating fluids. The effusion of plasma which occurs during the first few hours after the infliction of a wound is greater when the cut surface has been treated with a stimulating wash than it is under ordinary management, and unless provision be made for its escape, it will be pretty sure, in a wound of considerable depth, to accumulate in sufficient quantity to cause inflammatory disturbance from tension. When the antiseptic has left the wound the discharge will be trifling in amount, unless the irritation is continued by blood or serum pent up in sufficient quantity to cause disturbance, or by some other accidental circumstance exciting the nerves of the part. If the tube enters obliquely, cut the outer extremity obliquely; lay the retaining threads on the surface; if the wound is to be closed as after amputation, use carbolized silk for sutures,[1] as it is very superior to wire, not only on account of its perfect suppleness, but because its actively antiseptic character insures absence of putrefaction in the track of the wound; the spray is never more useful than in the introduction of the sutures; if it be not employed the wound must be injected with lotion after the insertion of the last stitch, to destroy any mischief that may have entered through regurgitation of blood that oozes into the cavity during the sewing; if strapping is required common adhesive plaster may be rendered antiseptic by dipping it for a second or two in a watery solution of the acid, and it is most convenient to have the lotion hot; the ends should be overlapped by the gauze; apply to the cicatrizing part a layer of the oiled silk protective, wet with the watery solution, and having a hole for the drainage-tube, for cicatrization is retarded when the acid is allowed to act immediately on the margins of the wound, and it is therefore necessary to protect the part by interposing between it and the gauze a layer of some impermeable material; apply eight layers of the gauze, of such size as to cover all the wound and the adjacent parts; in situations where there is not as much extent of skin for the gauze to overlap as is desirable, as in the vicinity of the pubes, the deficiency of surface may be compensated by using the gauze in a thicker mass, say in sixteen or thirty-two layers; dip the first layer in the solution, for if the gauze were applied dry, some active septic particle adhering to its surface might enter the blood or serum at the outlet of the wound, and propagate putrefaction to the interior; between the last two layers place a piece of Mackintosh of smaller size

[1] Silk thread with the interstices among the fibres filled up with wax containing about a tenth part of carbolic acid; mix the acid with melted beeswax; immerse the silk, and when thoroughly steeped draw it out through a cloth to remove superfluous wax.

than the layers of gauze; apply the last layer so as to cover in completely the Mackintosh; this impermeable cloth is used to prevent the discharge from going directly through the dressing, because, if a considerable quantity went through, the acid might all be washed out within twenty-four hours, and then putrefaction would spread inwards to the wound; the Mackintosh having no antiseptic property, except mechanically by its impermeability, but, on the contrary, being like other indifferent materials covered more or less with septic matter, it is necessary when the dressing consists of more pieces than one, that the Mackintosh be well covered in at the place of junction of the two pieces, for if it were allowed to project uncovered in the vicinity of the wound it might communicate septic mischief; retain the dressings by bandages of the antiseptic gauze, over which elastic webbing may be applied when the bandage is not sufficient, as in wounds or abscesses in the groin; inspect the wound on the day after its infliction, whether it be accidental or the result of operation, and change the dressing only in case the discharge is liable to extend beyond the edge of the folded gauze; during the subsequent progress of the case leave the gauze undisturbed for periods varying from two days to a week, according to the diminution of the effusion; in re-dressing continue the spray uninterruptedly on the part; while the bandage is being cut or removed, the patient, or an assistant, keeps his hand over the site of the wound, to prevent the dressing from rising *en masse*, and pumping in septic air; in raising the folded gauze take care that the spray passes into the angle between it and the skin; remove the drainage-tubes, cleanse them in the carbolic-acid solution, and before re-introducing them cut off such portions as the granulations in the wound render necessary to bring the external extremity flush with the surface of the skin; lay aside the gauze which is soaked, but use the Mackintosh again after cleaning it with carbolic-acid solution.[1]

2. **Cotton-wool**[2] is used to intercept germs in the air. Apply it as follows to open wounds, as after amputation: Select three or four pounds of wool of good quality, white and clear of foreign matters; strip off any glazed surface; tear the sheets into strips about one foot wide, and roll them up; prepare several rolled bandages of unwashed linen or cotton, two inches wide and eight to ten yards long; remove the patient from a septic atmosphere, as that of a ward, during the dressing; apply ligatures to all bleeding points; wash the wound with a solution of carbolic acid (one per cent); the wound being held open, fill it completely with little wads of loose cotton-wool evenly superposed; now apply the rollers of cotton-wool over and around the limb evenly and methodically, so as to surround it with a homogeneous mass of even thickness, which must in all cases

[1] J. Lister. [2] A. Guérin; T. B. Curtis.

extend beyond the first joint above the seat of the wound. Apply roller after roller of the wool so long as strong pressure through the mass gives any pain; next apply the common bandage for the purpose of securing the wool, the turns being up and down the limb, circular, oblique, or spiral, as will best mould the mass into shape; wherever there is any bulging the bandage should be applied, the end being equally compressed with the sides; thus gradually cover the wool at every point by successive over-lapping of the bandage, making each roller firmer and firmer as the application progresses, the last being applied with all the power of the strongest hands; place the patient in bed; lay the limb on a folded sheet and cover with a cradle. If the case progress favorably, the dressings should not be disturbed for two or three weeks, except they become loosened, when additional layers of bandage should be applied to secure anew the firm consistency and elastic compression of the freshly applied dressing. On the fifteenth or twentieth day remove the bandages, and tear open the cotton-wool, layer by layer, along the anterior aspect of the wound. The wound will be found granulating in a healthy manner, the bone being well covered, and the limb as natural as at the time of the operation. The further treatment is that of an open granulating sore. Throughout the treatment the dressings must be watched to detect signs of hæmorrhage, and the temperature must be taken for evidences of impending or existing erysipelas, septicæmia, and pyæmia.

IV. ORDINARY DRESSINGS.

The special form of dressing must be determined by the nature, conditions, and peculiarities of each individual wound, and the method of repair which is sought to be obtained. In treatment, wounds are either closed or open; the former tend to primary union, the latter to secondary union, or union by granulation. Although the morphological changes in the tissues are the same in both cases,[1] the method of closing wounds immediately after an operation is to be preferred whenever the conditions are favorable to primary union, as the wound heals more rapidly, with less inflammation, and gives more perfect results, especially when immediate union is secured, which is the best imaginable process of healing.[2]

The subcutaneous wound must be carefully protected from the admission of air to the interior, as follows: On the withdrawal of the knife, press the end of the finger firmly upon the cut, then apply an adhesive strip over the wound, upon this place a mass of cotton batting and retain it with adhesive plaster; re-dressing is not required until the union is complete, unless suppuration occur. Incised

[1] T. Billroth. [2] Sir J. Paget.

wounds repair by primary union, when their surfaces are accurately maintained in apposition without the intervention of any unorganizable matter, and should be treated with a view to such union, unless the conditions make it desirable that repair should be by granulation.

1. **Collodion** is the best application if the wound is very superficial and does not gape; or gauze may be added to give more support, as follows: Cut strips one or two inches wide, and three or four inches long, and with a camel's-hair brush moisten one end of the strip, which quickly dries and adheres; then treat the other in the same manner; when the wound is covered with the gauze, apply the collodion freely over the whole material, thus hermetically sealing the wound with a dressing impervious to water. Collodion dressings rarely require removal until the repair is complete.

2. **Adhesive plaster** must be used when the wound involves the entire skin and gapes freely; it answers best when bone underlies the wound, as in wounds of the scalp. Cut the plaster in the direction of the length of the roll, and of sufficient length to extend two or three inches upon either side of the wound; compress the lips of the wound firmly when the strip is applied, as there is always a slight yielding of the margins, which may amount to a complete separation; the strips may be parallel across the wound, or so oblique as to cross each other. When adhesive plaster is removed, great care is necessary to avoid disturbing the apposed surfaces; raise each strip equally from both ends to the margin of the wound, and turn it gently over on its axis, while extending each extremity.

3. **The interrupted suture** must be applied when the wound is of such extent or so situated that the adhesive strip does not sufficiently support its margins. Various materials are used for sutures, as catgut and horse-hair, silk and hemp, silver, iron, and lead. Catgut, carbolized, is entirely unirritating, but may be absorbed too soon; horse-hair is unirritating and reliable, but it is not very flexible where the knot is formed; silk is irritating, but is generally preferred, the best being that used by dentists, three-thread; hemp resembles silk, but is not flexible; the best is three-ply manilla, hardash.[1] The metallic sutures are unirritating and entirely reliable; the silver is more generally used. If the non-metallic are used, needles of various shapes are required (Fig. 31). The needle with curved extremity (*c*) is more generally used; a needle curved throughout its entire length (*b*) is useful when the wound is deeply seated; the straight needle (*a*), with sharp point and three cutting edges, is serviceable in

FIG. 31.

[1] C. J. Cleborne, U. S. N.

wounds on a slightly elevated surface; in deeply seated wounds needle forceps are useful (Fig. 32). If metallic sutures are used, they may be inserted with the ordinary suture needle, held by forceps. The suture-pin conductor (Fig. 33) is very useful; it consists of a slightly-curved needle fixed in a handle, somewhat enlarged for half an inch near its point, and perforated on the concave side.

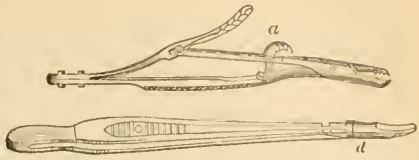


Fig. 32.

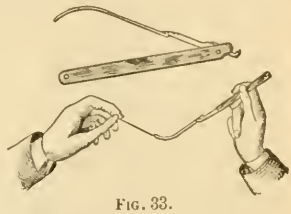


Fig. 33.

Proceed as follows: Pass the needle, armed with the ligature, from without inwards through one lip of the wound, at a distance from its margin varying from a line to one third of an inch, according to the tension of the parts, at a depth sufficient to support the deep parts of the wound, and continue it through the opposite lip from within outwards at a point exactly corresponding to the insertion; tie with the reef-knot, and twist wire with sufficient firmness to press the surfaces well together without causing ponting or wrinkling of the lips. (Fig. 34.)

Fig. 34.

The distance between the sutures should not exceed half an inch, and it is better, when silver wire is used, not to exceed one fourth of an inch. Between wide sutures apply adhesive strips.

4. **The twisted suture** (Fig. 34) must be used when the wound involves deeper tissues and the surfaces are approximated with difficulty.

Pass a needle of steel, silver, or other unirritating metal through the sides of a wound, as in the interrupted suture, and then twist the thread around the ends in the form of a figure-of-eight (Fig. 35); when several needles are required they should all be introduced before the thread is applied, which should then also take a diagonal direction between the pins (Fig. 35) to protect the intervening spaces.

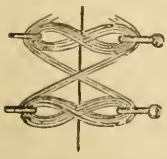


Fig. 35.

Fig. 36.

5. **The quilled suture** (Fig. 36) is to be preferred when the wound involves the perineum; pass a double thread or wire as in the interrupted suture, but at greater distances, and tie the ends over quills or pieces of bougie

laid on the sides of the wound ; fine interrupted sutures should also be inserted in the intervals to sustain the lips in apposition.

V. OPEN TREATMENT.

The open method is adapted to those wounds which heal by secondary union. This process involves the separation of the dead particles and the formation of granulation tissue. From the infliction of the wound and the covering of the surfaces with granulations there is a constant liability to absorption of septic matters from the wound into the blood, but when the granulations are complete this danger no longer exists.[1] Though suppuration generally accompanies the process, it is not necessary to the organization and development of granulations. If the wound is maintained in a condition of perfect freedom from irritating matters arising from filth and decomposition, granulations will form and cast off the stratum of dead tissues without suppuration.[1] In the treatment of an open wound, therefore, it is important both to preserve the surfaces from every source of defilement from filth, and to thoroughly disinfect them, the air, and the dressings, so that active septic ferments cannot gain access to the wound, or, if present, will be rendered inert. In dressing a granulating wound, avoid breaking the granulations; for if they bleed, septic poisons may enter the circulation.[1]

1. **Incised wounds** may be treated by the open method, as follows:[2] Place the part in an easy position, support it by a pillow of oakum, cover with gauze, and protect from the contact of bedclothes with a cradle; use no sutures except at the angle of the wound, nor adhesive plasters, oiled silk, compress, or bandage; wash the wound at frequent intervals with carbolized water by means of a douche, and pour over it balsam of Peru ; receive the drainage in a disinfected vessel, and remove it frequently; when suppuration has nearly subsided approximate and mould the flaps with adhesive plaster.

2. **Contused wounds** are made with blunt instruments, which so lacerate the tissues that the dead particles prevent immediate union. One of two methods of treatment must be adopted: (1.) When the contusion is slight, convert the lacerated into an incised surface by cutting away the lacerated tissue with a sharp knife and then treating it as an incised wound. (2.) If the contusion is severe, secure the separation of dead matters by warm moist application containing a sufficient quantity of carbolic solution to disinfect sloughs; union will be by granulation.

3. **Punctured wounds** made with blunt-pointed instruments tend to unite by granulation. Cleanse the wound of all foreign matters and disinfect it with carbolic solution ; if superficial, attempt to se-

[1] J. Lister. [2] J. R. Wood.

cure union by compresses so adjusted as to bring the surfaces of the entire track in apposition; if the contusion is severe, denoted by duskiness of the margins, apply warm moist dressings to promote granulation; if the surface wound unites and pus forms deeply, the external wound must be reopened.

VI. HOT-WATER TREATMENT.[1]

This method is adapted to wounds much lacerated or in gangrenous tissues, and liable to profuse suppuration; submersion of such wounds diminishes fever, limits the area of acute inflammation, restrains and arrests erysipelas and gangrene, and prevents purulent infiltration, septicæmia, and pyæmia; it is not necessary to preserve an absolute uniform temperature of the water, but it should always feel warm to the patient, and this temperature is found to be from 95° F. to 100° F; in cases of incipient or progressive gangrene, the temperature may be raised to 110° F. In case of a recent wound, where secondary hæmorrhage is at all liable to occur, dress the limb for a few hours with either warm or cold fomentations, but apply neither sutures, adhesive plasters, nor bandages. At the expiration of this time commence either the bath or the warm water fomentations, and employ them thereafter systematically; the patient is at liberty at any time to lift the limb from the bath, and he generally does this pretty often, to see how it is progressing. Warm-water fomentations are second in value to submersion, in the preventing and cure of inflammation, and are to be reserved for those examples in which submersion, for one or another reason, cannot properly be employed. Fomentations should be employed after about the tenth day in all those cases in which submersion is at first practiced; when the patient is weary of the confinement of the bath, the limb is taken out and fomented during the night. In using the fomentations, envelop the wound and limb in several folds of sheet lint or soft old muslin, saturated with warm water, the whole being enclosed in oiled silk or vulcanized rubber; this is to be changed about once in four or six hours. The lower extremities can only be completely and permanently submerged to a point three or four inches below the knee, and the upper extremities to a point a few inches above the elbow, consequently, submersion is limited to those portions of the extremities which are below the points mentioned. A vessel, in which the part can be immersed, may be obtained in any household; but a more convenient receptacle is made as follows: —

Construct an oblong zinc bath, twenty-three inches long by eight inches wide and eight in depth, with somewhat flaring margins where the limb is to enter, supplied with a movable cover, which leaves an opening for the limb, and pro-

[1] F. H. Hamilton.

vided with a stop-cock to draw off and renew the water; along the upper and outer margin of the bath are arranged small wire-pins, upon which pieces of cloth may be fastened for the purpose of suspending the limb; care must be taken not to allow the limb to rest against the edge of the bath, so as to interfere with the circulation, and it must be carefully adjusted beside the bed, in such a position as will be most comfortable to the patient.

CHAPTER IX.

THE APPLIANCES.

Simplicity is not more important in the mediate than in the immediate dressings of wounds. It is better to apply nothing at all than too much, if sutures maintain parts accurately together.[1] But the wound must be preserved in a state of complete repose, and in order to secure that position additional dressings are often required, both to support the first and to maintain the parts in a condition of rest. These should be selected and applied so as to preserve cleanliness, allow free circulation in the vessels, be easy of removal and reapplication, and yet fulfill their special purposes.

I. BANDAGES.

The roller bandage is now employed almost exclusively as a retentive dressing. Though simple in construction, and easy of application, it has proved a fruitful source of evil in the hands of the injudicious. The danger lies in undue compression of recently injured or inflamed parts, inducing mortification, especially of the extremities; cases have also been litigated for alleged atrophy and paralysis of the limbs resulting from its use. The materials employed are muslin, flannel, linen, calico, and elastic cloth. Muslin is generaliy selected of a coarse, unglazed quality. Flannel is useful when it is desirable to secure warmth. The cloth should be cut or torn into strips of one, two, or three inches in width, according to the part to which it is to be applied.

1. **The single head roller** (Fig. 37) consists of a single piece. When applied to a limb, especially for compression, it should always commence at the extremity, and proceed upwards. Apply the first turns most firmly, in order to compress the superficial veins from below upwards; no one turn should be more firm than those below. The best general rule for its application is as follows: It should be done quickly, without pain, with ease, and with elegance.[2]

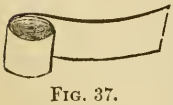


Fig. 37.

[1] J. Croft.

[2] Hippocrates.

Take the cylinder in the palm of the right hand, and with the thumb and fingers of the left seize the free extremity, drawing the roller out six to ten inches between the thumb and fingers of the right hand, the cylinder unrolling in its palm; place the external surface upon the limb, and retaining it with the first and second fingers of the left hand, pass the cylinder under the limb, and by the aid of the third and fourth fingers of the left hand make a turn or two to fix the initial extremity of the bandage. In continuing the application have but little of the bandage unrolled, keep the cylinder close to the limb, and pass it from one hand to the other without reaching with the respective hands beyond the centre of the limb.

2. **The circular bandage** (Fig. 38) passes nearly horizontally around portions of the limb of equal diameter, one turn overlapping the other at fixed intervals.

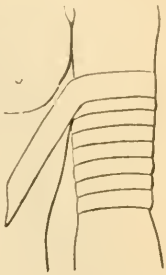


Fig. 38.

3. **The spiral bandage** (Fig. 39) ascends a more or less conical portion of the limb, each succeeding turn partially overlapping the other, with reverse turns on the more conical parts, as follows: —

At the point where the roller ascends the limb so rapidly as to be irregularly applied, press the ends of the two forefingers of the left hand upon the upper fourth of the bandage, and retain it firmly at that point; then relaxing the bandage, turn the cylinder, held between the fingers and thumb, quickly and

Fig. 39.

completely over, by pronating the right hand, thus applying the upper surface in turn to the limb.

It is applied to a finger as follows: Take a bandage an inch in width, and commencing at the wrist make a circular turn, leaving free two or three inches at the initial extremity (Fig. 40); then cross the back of the hand diagonally to the root of the finger to be bandaged; then along the palmar surface of the dry

finger to its tip, where the spiral commences, with or without reverses according to the shape of the finger; when the finger is covered the bandage should pass to the side of the wrist opposite to that where it began, and be tied to the initial extremity. If it is required to bandage other fingers, instead of tying the two extremities, the bandage should pass around the wrist and across the back of the hand to the root of the finger, and be applied as above described. In this manner all the fingers may be bandaged with a single roller.

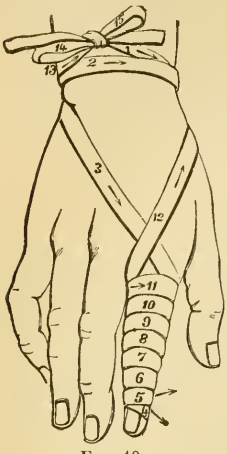


FIG. 40.

4. **The spica** (Fig. 41) is applied on the upper part of the arm and thorax, of the thigh and pelvis, and of the thumb.

In applying it to the groin (Fig. 41), stand in front of the patient, place the initial extremity on his right side, and carry the cylinder circularly around the body twice, then carry it downwards and around the thigh, passing from the inside to the outside of the limb, then upwards around the body, crossing the downward turn in the groin. The first turn around the thigh should be as low as its upper fourth, and the subsequent turns should ascend regularly until the requisite pressure is attained.

FIG. 41.

5. **The Figure-of-eight bandage** (Fig. 42) is generally applied about the joints.

At the knee, continue the bandage of the leg, after it has reached the lower border of the joint, by passing the cylinder behind the knee, obliquely across the ham to the opposite side of the limb, around the thigh, and downwards again obliquely across the ham to the point of departure; each successive turn should overlap the other until the knee is covered, or the object attained. If the figure of eight is applied only to the knee (Fig. 41), commence with two circular turns around the leg just below the joint, and then carry the cylinder obliquely upwards across the ham, around the thigh, and again downwards as before described.

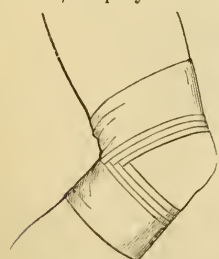


FIG. 42.

6. **The double-headed bandage** (Fig. 43) is applied as follows: —

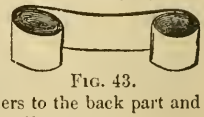


FIG. 43.

Take the two cylinders in the hands, and, placing the outer surface of the central portion upon the anterior part, carry the two cylinders to the back part and exchange, then bring them forward (Fig. 44), and reverse, if necessary.

7. **The T bandage** consists of the simple bandage with one or two pieces added at right angles (Fig. 45), and is employed in the diseases of the region of the perineum and anus. Pass the horizontal portion around the pelvis and firmly secure the vertical strips behind, after being passed under the perineum and the dressings.

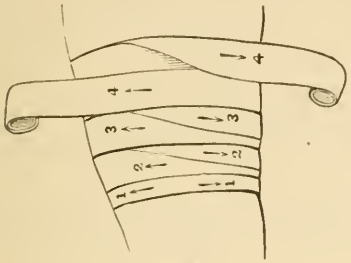


FIG. 44.

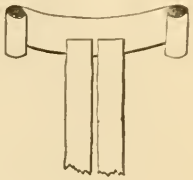


FIG. 45.

8. **The recurrent bandage** should be five yards long and two inches wide; it is applied to the head as follows: —

The roller is first passed two or three times around the head in a line running just above the eyebrows and the ears, and below the occipital protuberance; next, at the centre of the forehead, the cylinder is reversed and carried directly over the head to the circular turns behind, where it is again reversed, and carried back to the forehead, overlapping the former about one third, as usual; these reverses to be continued until first one and then the other side of the head is covered; and the whole is completed by two or three firm circular turns as at the commencement; the reverses are to be held by the fingers of an assistant.

II. PLASTIC APPARATUS.[1]

This form of appliance is required when operation-wounds are of such nature and location as to require absolute protection of the part from all motion. It must be applied with great care, and with due regard to the liability to strangulation of parts recently submitted to operation. By way of caution, it should be stated that all starch, chalk, and plaster of Paris splints contract on drying, and hence are liable to be followed by harm.[2] But though unfavorable results have followed its injudicious use, this dressing is invaluable when properly used.[3] The best safeguard against accidents is careful padding of the limb and parts adjacent to the wound with cotton wool.[4] There must be constant watchfulness of the toes or fingers involved: if these parts become bluish, red, cold, or even insensible, the dressing should at once be removed, or if the patient complains of severe pain under the dressing it is well to remove it.[3]

[1] S. B. St. John. [2] T. Bryant. [3] T. Billroth. [4] Burggraeve.

1. **The starch bandage** is made with starch or dextrine as follows: —

Take common starch, a sufficient quantity, and boil it in water a few minutes. Dextrine is very readily prepared by thoroughly mixing with it spirits of camphor or brandy, 100 parts of the former to 60 of the latter, and adding about 40 parts of warm water. Envelop the limb with cotton wadding, so thickly applied as to cover all the prominences and fill the cavities; over this apply a roller well saturated with the starch; along the sides of the limb apply pasteboard splints of proper thickness, soaked in hot water, and nicely shaped to the limb; repeat the bandage twice, and saturate the whole with starch, rubbed in with the hands or a brush. When the starch is completely dry, cut out a piece, and bring the edges together with strong tapes, or leather straps with buckles; hasten the drying, by suspending the limb, or by applying hot bricks or bottles of hot water.

2. **The gypsum splint** is in many respects preferable to starch, and chiefly owing to the rapidity of its consolidation. It may be applied to a part of the circumference of a limb, or to the entire limb. When applied to a part of the limb as a splint, proceed as follows:[1]—

First shave or slightly oil the limb; next select a piece of old coarse washed muslin of a size so that when folded about four thicknesses it is wide enough to envelop more than half of the circumference of the limb, and long enough to extend from a little below the under surface of the knee to about five inches below the heel; select fine, well dried white plaster, and, before using, mix a small portion with water in a spoon and allow it to set, to ascertain the length of time requisite for that process; if it is over five minutes, dissolve a small quantity of common salt in the water before adding the plaster; the more salt is added, the sooner the plaster will set; if delay be necessary, the addition of a few drops of carpenter's glue or mucilage will subserve that end; equal parts of water and plaster are the best proportions; sprinkle the plaster in the water, and gradually mix with it; immerse the cloth, unfolded, in the solution and saturate well; fold quickly, as before arranged, and lay it on a flat surface, such as a board or a table, and smooth once or twice with the hand in order to remove any irregularities of its surface, and then, with the help of an assistant, apply it to the posterior surface of the limb; turn up the portion extending below the heel on the sole of the foot, and fold the sides over the dorsum, and make a fold at the ankle on either side; apply a roller bandage pretty firmly over all; hold the limb in a proper position, extension being made, if necessary, by the surgeon, until the plaster becomes hard; the time required in preparing the cloth, mixing the plaster, and applying the casing to the limb need not be more than fifteen minutes.

When the dressing is to enclose the limb completely, all the details of preparation and application must be carefully attended to in order to insure safety and success. The following method[2] secures a neat and serviceable dressing: —

Select clean cotton batting, smooth and fresh plaster of Paris, and the flimsiest cotton cloth, as crinoline, which tear into strips of two and a half or three inches in width, make one strip nine to twelve yards long, and the remainder three yards long; lay the latter on a kitchen table or board, and have the

[1] J. L. Little. [2] D. W. Yandell.

plaster well rubbed into the cloth; roll them into cylinders; into an ordinary wash-basin one third full of water a little warm, put two heaping tablespoonfuls of powdered alum; have the whites of half a dozen fresh eggs beaten into a froth; unfold the batting carefully, that it may be in a sheet rather than a roll, and envelop the whole limb, covering well the bony prominences; secure the cotton with the long roller, into which no plaster has been rubbed; put the plaster rollers into the basin of water; squeeze and press them with your hand until well wetted; apply them to the limb, one after another, until the dressing is sufficiently firm; three layers are usually required; the rollers may be put on longitudinally instead of circularly; make no reverse turns of the bandage, as they are unnecessary, and give the dressing a clumsier appearance than it otherwise would have; smooth each layer of bandage nicely with the hand, which will add to the firmness of the dressing and make it dry more quickly; wait a few moments for the plaster to dry; the alum added to the water will greatly facilitate this; when comparatively dry apply the whites of the eggs over the plaster; then apply a roller without plaster over this; or cut the roller into strips and lay them along the length of the limb; the egg prevents the plaster from chipping; the additional roller assists this, and gives to the dressing a finish which it does not otherwise have.

The gypsum may be applied to the bandage by means of an apparatus consisting of a tin pan with a roller.

Pass one end of the bandage under a rod and attach it to a roller; put the plaster on the bandage, turn the roller, and as the bandage passes under the rod the plaster is evenly applied.

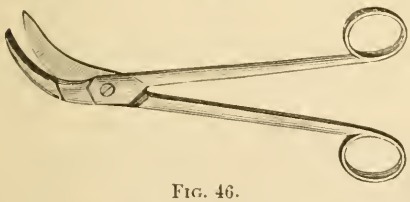


Fig. 46.

In removing the dressing which encircles the limb, it must be cut down in the middle line with a sharp-pointed knife or with shears made for that purpose (Fig. 46).[1]

3. **The silica bandages**[2] are made of the silicates of potash and soda dissolved in an excess of caustic alkali. They form a cheap and efficient fixed dressing, which does not contract in drying, and is very light and clean.

Apply it as follows: cover the part with cotton wool, lint, or a thin flannel roller, and apply over this a common dry bandage; with a brush or sponge apply a coat of the silicate; repeat the bandage and silicate until two or three layers cover the limb; when the last layer is dry, put on another coat of the silicate so as to give an even surface; expose the limb to the air for about half an hour, when the bandage will be firm enough to prevent movement; the bandage continues to harden for about two or three days. To give greater strength to the bandage, mix whitening with the silicate in sufficient quantity to give the consistence of batter.[3] A rapidly setting and extremely firm splint may also be procured by covering the limb with cotton-wool, lint, wool, a worsted stocking, or any soft protecting material, and apply strips of linen, bandage, or paper saturated with silicate of soda mixed or not with a salt of lime, such as chalk, whitening, or plaster of Paris.

[1] G. W. Wackerhagen. [2] W. W. Wagstaffe. [3] W. C. Elliott.

CHAPTER X.

THE REPAIR.

After an operation an entirely new case begins, a case not of disease, but of injury.[1] The immediate effects of the operation are seen in a variation of temperature; at first it sinks, but not below the normal; then it ascends, either slowly or suddenly, for a few hours; in some cases there are intercurrent falls of temperature, usually followed by renewed elevations.[2] The principal factors in reducing bodily heat immediately after operations are loss of blood, the narcosis of the anæsthetic, the pain of the wound, and prolonged exposure of the body.[3] The intensity of this shock commonly determines the time, and, in a less degree, the intensity of the reaction which in the ordinary course immediately follows; in some cases, even after severe wounds and much depression, the reaction does not go beyond the recovery of the natural standard of the heart's action, and of other functions; there are neither fever nor other signs of general disorder, and repair may make unhindered progress.[1] In every form of wound a new histological element is engrafted upon the part, namely, the migrating cells, and it is upon the determination of their relations and changes that the future condition of the wound depends; if they are removed from the tissue, resolution, or a return to the natural state, will result; if they undergo fatty degeneration, pus will be formed; and if they become organized, new tissues will be incorporated with the old.[4] Repair may therefore proceed to its termination with but little more excitement than attends physiological processes, or complications may arise which modify its progress and its completion. When the process is normal there is an orderly series of changes, noticeable at every stage, and when complications occur there are marked and characteristic deviations.

I. INDICATIONS.

It is of the first importance to be able to determine at all times the nature of the changes which are taking place in the injured part, whether reparative or destructive. The most reliable indications of these changes are found in the appearance of the wound, the degree of bodily temperature or fever, and the nature of the pulse. Whenever there is any considerable deviation from the normal healing of the part, these features of every case are notably affected, sometimes so much in advance as to give the surgeon timely warning of approaching danger and enable him to protect the patient from serious

[1] Sir J. Paget. [2] E. Wagner. [3] T. Billroth. [4] E. Rindfleisch.

consequences. The state of the wound, the fever, and the pulse, therefore, should be accurately recorded at least twice daily; carefully observed, they form a group of most reliable indices of the hourly progress of the case. The phenomena which they respectively present are so interdependent that they must be regarded as a single series of symptoms having a common cause. Every change should therefore be duly noted, and its significance appreciated.

1. **The wound** is the seat of those local changes, reparative or destructive, which occur in the progress of repair, whether it pursue a normal or abnormal course; these changes are largely influenced by the immediate conditions which surround the wound.

2. **The fever,** denoted by bodily temperature, is, as a rule, the measure of blood heating by the inflammatory process,[1] and of blood-poisoning by the absorption of dead and septic matters into the circulation.[2] Any sudden increase of temperature always denotes some important change about to take place in the wound, and hence the variations of fever announce conditions in the reparative action, favorable or unfavorable, many hours before they are indicated by local appearances or symptoms.[3]

3. **The pulse,** though much influenced by mental states and other conditions foreign to the wound, is still a reliable index of the degree of arterial tension, or resistance of the organism to the depression and exhaustion which the irritants derived from the wound induce.

II. NORMAL REPAIR.

The process of repair may proceed in a normal manner under apparently very different conditions, namely, in closed and open wounds. In the former, union may be immediate, or by primary adhesion, and in the latter it may by granulations or of granulations.[4] Different as these processes appear at first glance, the morphological changes in the tissues are in both cases the same.[5] Passing over the familiar textural changes by which union of wounds is effected, the question of greatest practical interest is as to the conditions most favorable to normal repair in these two classes of wounds, and the methods by which they are secured.

It may be stated as an accepted principle that the best imaginable process of healing requires, as one essential condition, that there shall be an absence of all inflammation.[4] This mode of repair is truly physiological, and closely resembles the normal growth of tissues. But the repair is still normal when, in certain wounds, the inflammation is limited in its effects. In union by adhesion an inflammatory process ensues which may be regarded as necessary for the production of new reparative material, but it should not go be-

[1] J. Simon. [2] T. Billroth. [3] T. P. Pick. [4] Sir J. Paget. [5] T. Billroth.

yond this, for its continuance is a hindrance to that organization of the reparative material essential to complete adhesion; so in healing by granulation, if inflammation is present, and the lowest degree is best, it is only for the production of the first material for granulation.[1] In general, the degree of inflammation will depend upon the freedom of the wound from the action of putrefactive matters, and the presence and activity of these agents will depend largely upon the immediate care which the wound receives; as in the kind of dressings employed, the time and method of their renewal, the protection of the parts from filth, and the prevention of collections of septic ferments. The different methods of treatment variously affect these results, and hence the difference in the clinical history of wounds according to the kind of dressings applied. The daily clinical record of wounds of equal average severity, treated by these several methods, should be thoroughly understood, for the choice of the particular method in any given case may involve the vital question of the results of the operation.

1. **The antiseptic method**,[2] when carried out in all its details, so effectually protects the injured parts from the dangers of atmospheric exposure that there is far less need of attending closely to the patient's constitutional condition. The following is an average daily record of ordinary uncomplicated wounds, closed and open, treated antiseptically, the patient being a healthy adult, having a normal pulse of 82: —

1st. The closed wound is slightly swollen and red at its margins, especially about the drain tube; the open wound has a dull grayish appearance; temperature 100° F., pulse 92; no symptoms of fever; dressings renewed owing to the profuse serous discharge; no odor.

2d. No change in closed wound; open wound is covered with a thin creamy layer; temperature 99½° F., pulse 88; appetite good; no symptoms of fever; dressings renewed; less serous flow; drain tube renewed; no odor.

3d. No change in closed wound; open wound still covered with a thin white secretion; temperature 98½° F. to 99½° F., pulse 86; no general symptoms; dressings continued; no putrefactive odor.

4th. Closed wound united, except where drain tube is inserted; open wound shows granulations, with slight secretion; temperature and pulse normal: remove any sutures not required, and drain-tube from closed wound; apply balsam Peru to open wound; no putrefactive odor.

5th to 10th days. No change in symptoms; dressings not renewed. Wounds now rapidly consolidate without further change.

2. **The ordinary dressings**[3] give the following daily record in average uncomplicated wounds, closed and open, in a healthy adult: —

1st. The margins of the closed wound gradually become red, swollen, hot, and tender, and the surface of the open wound has a gelatinous, grayish appearance,

[1] Sir J. Paget. [2] J. Lister; Bellevue Hosp. Reports.
[3] T. Billroth; Bellevue Hosp. Reports.

with yellowish or grayish-red small particles, which are small fragments of dead tissue still adherent; temperature 100° F., pulse 92; treatment, cooling regimen; dressings unchanged.

2d. The closed wound is more swollen, hot, and tender, and there is greater strain on the sutures; a trace of reddish-yellow, thin fluid is seen over the open wound; the tissues appear more regularly grayish-red and gelatinous, and their boundaries become more indistinct; temperature 101° F., pulse 104; there is thirst, slight headache, suppression of secretions, and restlessness; treatment, sponging, laxatives, cold drinks; dressings renewed when soiled by discharges.

3d. The closed wound is still more swollen, hot, and tender, the sutures which have been most tense are loosened by ulceration, pus oozes from the deeper parts; the secretion of the open wound is pure yellow, somewhat thicker, most of the yellow dead particles are detached and flow off, and the surface becomes more even and regularly red, covered with red nodules, scarcely as large as a millet seed, the granulations; temperature at its maximum rarely exceeds 104° F.: pulse attains its highest range, 112; continue cooling regimen; remove any sutures which have loosened; odor putrefactive.

4th. The margins of the closed wound are less swollen, hot, and tender, and the surfaces are united; pus flows from deep parts; the open wound is well covered with pus, but the granulations have increased in size and numbers; temperature 101° F., pulse 96; treatment, nutritious foods, and removal of the remaining sutures, unless some parts are still supported by them; odor putrefactive.

5th to 10th. Rapid subsidence of the inflammatory symptoms of both wounds; the swelling of the closed wound decreases; the open wound becomes filled with granulations to a level with the skin; along the margin the surface is dry, and a slight red line appears, followed by a wider white band, the commencing cicatrization or formation of the new epidermis.

3. **The hot water dressing**[1] is applied to wounds in a contused, sloughy, or gangrenous condition; before there are visible symptoms of repair the dead tissues must be separated; the progress of such wounds towards healing must at first be slow, as the daily clinical record proves of a healthy adult: —

1st. The first effect of the water is agreeable to the patient, though pain is not entirely relieved; temperature 100° F., pulse 96.

2d and 3d days. The parts adjacent are swollen, and the integuments white and sodden; temperature 98½° F. to 100° F., pulse 88 to 92.

5th, 6th, 7th. The parts are largely swollen from œdema, and the granulations are covered with white exudation; temperature and pulse normal.

7th to 10th. The œdema continues, the granulations are abundant, and either of a fresh, red appearance or still covered with the exudation. At this period, or earlier, according to the indication, fomentations should be substituted for submersion. The œdema subsides, but its final disappearance is delayed sometimes to a period beyond cicatrization, the cicatrix being often depressed thereby for months. In a recent wound, where secondary hæmorrhage is liable to occur, dress the limb for a few hours with warm or cold application, but without sutures, plasters, or bandages; then resort to the bath or fomentations, as directed.

[1] F. H. Hamilton; Bellevue Hosp. Reports.

But the course of normal repair is liable to various interruptions and complications. A wounded part appears to be a structure in which morbid conditions of the blood are peculiarly prone to manifest or localize themselves; if an exanthem, as measles, appear after an operation, the thickest of the eruption will be at and about the wound; the general malady of erysipelas may have its local expression chiefly or only at the wound, and scrofula or syphilis, previously latent in the system, may find at a wound a place more fit for their manifestation than any sound structure.[1]

III. HÆMORRHAGE.

Repair may be interrupted at any stage by hæmorrhage; the wound and tissues are thus filled with coagula, which separate the flaps, and, in softening, give rise to pus and very irritating matters.

1. **Intermediary hæmorrhage** may occur at any time subsequent to reaction, and before suppuration is established, namely, between the first and sixth days. It is the result of returning circulation, and if moderate, from small vessels, it demands no special attention, for in a few hours the progress of inflammation will prevent the slight oozings of blood; if the bleeding is excessive, or proceeds from larger vessels, it must be promptly arrested; if the limb is in a depending position, or a bandage causes ligation, change of position, and dressings, cold, or pressure may answer; if these measures do not promptly succeed, remove the dressings, open the wound, wipe away the clots, and secure the vessel with a ligature.[2]

2. **Secondary hæmorrhage**[3] occurs during the period of suppuration, or between the sixth and twentieth days, and especially about the fourteenth day; it may be sudden and severe, but more often it is slight at first. It may be due to many causes, the chief of which are sloughing of a contused artery, or of an artery contained in a slough; penetration of an artery by ulceration; failure to form a firm clot in its calibre; breaking down of the adhesions formed at the mouth of the vessel; imperfect closure of the breaches in wounded vessels; an unsealed end of the distal portion of a severed artery; impoverished blood from diathetic disorders, as scurvy, syphilis. If the bleeding is from a vein or small arteries, arrest it temporarily by pressure with the finger, and permanently with a roller bandage; if the bleeding is from a larger vessel, apply a bandage evenly from the extremity of the limb some distance above the wound, with a compress at the wound, and a second laid along the course of the artery on the proximal side; if there is oozing from small vessels in deep cavities, resort to hæmostatics, as persulphate or perchloride of iron; if the bleeding is parenchymatous, apply the actual cautery where the

[1] Sir J. Paget. [2] F. H. Hamilton. [3] J. A. Lidell.

parts are in a sloughing condition and arteries will not maintain the ligature, the cautery being so thoroughly applied as to destroy the entire slough and seal up the bleeding vessels; by ligature, if there is a wounded vessel at the seat of injury, tie both cut extremities; when compression has not proved effectual, ligate the trunk of the artery; if the limb or life is seriously threatened by delay or the use of other measures, resort to amputation of the limb.

3. **Parenchymatous hæmorrhage**[1] usually occurs as an oozing from the granulating or ulcerating surface of the wound, of blood neither venous nor arterial in appearance, but resembling what flows from dilated capillaries; it may also occur in the primary, intermediary, and secondary periods in the history of the wounds; in the primary period it is liable to attend operation-wounds made in inflamed tissues, the capillary blood-vessels being still paralyzed by the inflammatory process, and unable to contract and close the open vessel; in the intermediary period it occurs when the dilated capillaries are so feebly and imperfectly closed that in the vascular excitement attending reaction, the blood is forced out of the vessels into the wound; in the secondary period it is associated with pyæmia, and is caused by the obstruction of the veins of the part with coagula.[2] The treatment of capillary hæmorrhage after an operation must be with the application of a strong solution of persulphate or perchloride of iron directly to the bleeding surface, by laying on lint saturated with the styptic solution. If the seat of hæmorrhage is a stump, the dressings must be removed and the wound freely opened. If styptics are not present, apply water of the temperature of 160° F. by means of a sponge; if this fail, cauterize with the hot iron. Hæmorrhage in the secondary period from thrombosis is almost necessarily fatal, owing to the constitutional condition of the patient, and is to be met with styptics and pressure, and, if these fail, by ligature of the main artery if the patient is very low with pyæmia, or amputation if he is not too much reduced and pyæmia has not appeared.

IV. GANGRENE.

When there is complete loss of vitality of the tissues through chemical or mechanical action, death of the parts follows, as in complete arrest of the circulation by compression, or other mechanical cause.[3]

1. **Traumatic** gangrene may be one of the earliest complications of the wound, the margins rapidly becoming cold and assuming a shrunken, dark, or purplish appearance, the extent depending upon the amount of tissue involved. It may be caused by direct violence, the tissues being devitalized, as in crushing injuries in which the amputation has been performed too near the seat of injury; or by

[1] J. A. Lidell. [2] F. Stromeyer. [3] T. Billroth.

constriction or occlusion of the main artery or vein, or of the neighboring vessels also, as after shot injuries, which either sever the arteries or give rise to large inflammatory effusions that occlude the collateral channels;[1] or, finally, by improperly applied dressings which too much constrict the parts or the vessels. As repair cannot proceed until the dead tissues are removed, the treatment should aim to prevent extension of the gangrene, and secure an early separation of the dead structures. The first indication is met by removing every source of irritation, and promoting the circulation in the part, and the second by excision. Where the gangrene is limited to the integument, all the dead tissue should be removed with the knife or scissors, as far as practicable, and the remainder should be constantly disinfected by carbolic solution to prevent contamination of the wound; the process of separation should be hastened by moist and hot applications, as poultices. If the gangrene involve the limb, as after ligature of the artery, gun-shot, or tight bandaging, amputation, promptly performed, is the sole remedy, the point at which it should be practiced depending upon the place of vascular injury.[1]

2. **Phagedæna**[2] may occur as a round black slough, with thickened border, or in the spreading form in which the wound opens with an irregular edge, and a foul, sloughy surface; its origin is obscure, and though possibly due to carelessness in the use of materials in dressing wounds, hospital influences have not been proved to originate it, as in the case of hospital gangrene; little or no constitutional fever accompanies it, and it involves very little danger to life; in some cases the pain in the wound is very great, requiring large opiates, and again the sloughing spreads with but little pain; occasionally the pain ceases, and the temperature due to the traumatic fever falls to 98° F. twenty-four hours before the slough appears. The treatment consists in securing a healthy surface of the wound by the use of strong caustics, as nitric acid, while the patient is under an anæsthetic, and such general treatment with cathartics, anodynes, and tonics as the case may require.

3. **Hospital gangrene** appears as a pulpous or ulcerous change in the granulations of a wound, of a yellowish-gray color, and extends to the surrounding skin.[3] It is a contagious disease, and occurs in the wards of hospitals, overcrowded and badly ventilated and cleansed; it may attack any wound, at any stage of repair, as the result of inoculation, or may be generated where to all appearances there is no abrasion of even the cuticle; its first appearance in an open wound is marked by blackish-gray points, and suspension of the healthy secretion, the discharge becoming thin and sanious; the

[1] J. A. Lidell. [2] T. Holmes. [3] T. Billroth.

edges are livid, raised, and everted, while a broad erysipelatous area extends in the skin, and the whole part exhales an offensive and penetrating odor; in six to twenty-four hours the grayish spots multiply and completely cover the part with a pulpy, tenacious mass, through which ichorous fluid is discharged, the slough burrowing under the integuments, particularly in the direction of the cellular planes; circular sloughs separate, but not deeply, giving a ragged appearance to the wound; the general symptoms are pain in the part, often excruciating; fever is not uniform; when present is typhoid.[1] In the treatment, the patient should be isolated, in a well-aired room, and have nutritious diet; opium should be given to allay pain, and tonics, quinine and iron, to improve the general condition. The local treatment, which is of the greatest importance, should be first directed to thorough cleansing and disinfection of the wound, and for this purpose bromine [2] gives the best results: cleanse the affected part of all secretions, by washing with soaped water, remove with forceps and scissors all sloughy tissue, free the surface of all moisture by swabbing with lint and penetrating every recess, apply the pure bromine to the open wound by means of a glass pipette, and to the recesses by means of lint dipped in the bromine and forced into cavities; paint the surrounding tissues with a solution of bromine ℥i to water ℥ii; apply a poultice to relieve pain and promote separation of the slough.

Other useful remedies are permanganate of potassa,[3] a concentrated solution applied with a hair pencil, and lint saturated with the solution, to be repeated every three or four hours; spirits of turpentine [4] applied thoroughly every three or four hours; persulphate of iron; concentrated solution of carbolic acid.

V. INFLAMMATIONS.

Those forms of inflammation which, by their destructive local effects, seriously interfere with repair, depend upon septic processes in the wound; the degree of development of these inflammations, or whether they are developed at all, depends upon the nature of the wound, the mode of dressing, the state of the atmosphere in which the patient is, the mechanical factors which favor the entrance of putrid substances into the tissues and the blood, and the quality of such putrid substances.[5]

1. **Erythema** appears as a blush around the wound, without fever or other symptom; there is slight tumefaction from turgescence of the capillaries, and the migration of leucocytes into the cutis and subcutaneous areolar tissue.[6] It is due to the action of irritants upon the specially sensitive papillary body, which reacts to the stimulus by

[1] F. H. Hamilton, Jr.; J. Jones. [2] M. Goldsmith. [3] Hinkley.
[4] Hachenberg. [5] E. Wagner. [6] R. Volkman.

hyperæmia.[1] It may terminate in resolution or inflammation. The treatment indicated is cleanliness and cold.

2. **Erysipelas** has a toxic origin; the wound may be poisoned at the time of the operation and erysipelas follow within a few hours, or blood mixed with decomposing secretions may excite the disease on the second or third day; or the poison may reach the wound through the air, sponges, and dressings at any time; the inflammation is generally limited to the cutis, and spreads through the lymphatic network.[2] Organisms, as bacteria, are found in the vessels of the inflamed skin, the number varying with the progress and severity of the disease,[3] but their relation to its origin is undetermined. The attack is often ushered in by a chill, followed by a fever; the edges of the wound become red and swollen, and this area extends with burning, stinging pains; the temperature rapidly rises to 104° F. or 106° F., and fluctuates but slightly until the inflammation subsides; the disease continues a variable time, but rarely exceeds ten days. The indications are to cleanse and disinfect the wound and adjacent parts with carbolized water, 1 to 20; inject a stronger solution, 1 to 10, when practicable, into the inflamed connective tissue; apply cloths wet with a weaker solution, 1 to 60, to the external surface; secure perfect drainage of the wound; correct any existing derangements of the digestive organs; administer tr. ferri muriat. in full doses, and add quinine, stimulants, and nutritious food, as the case may require.

3. **Lymphangitis** may occur in any wound, and is due to a poison passing through the lymphatic vessels; this poison may be decomposed secretions from the wound, or putrid matters; it appears as fine red striæ, running longitudinally from the wound towards the swollen and sensitive glands; the limb is painful on motion; there is fever, loss of appetite, and general depression; the inflammation may terminate in resolution, or in the formation of abscess at some point.[2] The treatment should be to cleanse the wound of all irritating matters, and elevate the inflamed part.[4] If there is gastric derangement, give an active purgative, make application of soothing lotions to the inflamed vessels, and poultices to the glands; nitrate of silver applied to the track of the vessels, and injections of mercurial ointment, are often useful, but the latter may induce salivation;[5] wadding or moist warmth, applied to the limb, to maintain an elevated regular temperature is important;[2] if the inflammation becomes diffused, abscesses will form, which must be early opened.

4. **Septic inflammation** arises from putrid matters on wounds which diffuse rapidly in the meshes of the cellular tissues, and cause,

[1] E. Rindfleisch. [2] T. Billroth. [3] Lukomsky; W. Moxon.
[4] T. Bryant. [5] T. Holmes.

on the second, third, or fourth day, those forms of inflammation characterized by rapid extension and decomposition of the inflammatory product; subsequently, when there is already suppuration, and the wound is open, mechanical irritation, foreign bodies, or infection of the wound may induce phlegmonous suppuration around the wound.[1] The treatment should be the removal of every source of irritation, thorough cleansing of the wound, and disinfection of the entire area of inflammatory excitement with strong carbolic solutions.

5. **Acute inflammation** [1] may appear at any stage of the healing, but unless excited by local irritation, its occurrence becomes less probable as the time increases; it is most liable to attack wounds of those tissues in which, from ordinary causes or as if spontaneously, inflammation is most frequent, namely, the joints and the serous membranes. It may be of a sthenic or asthenic type; the former being attended with more swelling, pain, and redness, and a higher grade of fever; but the effects on the healing process are the same, namely, suspension of repair, and degeneration of the new-formed structures; granulations become œdematous or shrunken, thin serous discharge takes the place of pus, and new cuticle is cast off. The treatment of sthenic inflammation, when perilous to the part or to life, should be actively antiphlogistic, namely, bleeding, local or general, according to the condition of the patient and the seat of the wound; moist, soft applications to the part, with ice or cold irrigation; in the asthenic form, the remedies must be of an opposite kind, namely, wine and tonics internally, and warm poultices to maintain the heat of the part, with free use of disinfectant solutions.

6. **Chronic inflammation** [1] not unfrequently occurs in healing wounds, especially amputation and excision wounds, and is chiefly a local fault; the granulations become pale, firm, œdematous, the adjacent structures feel lumpy, heavy, firm, and consolidated, as if filled with half-organized matter; it destroys the natural mobility of parts, and is associated with tardy and insecure healing; if the healing is not far advanced, it may be dangerous through the usually coincident softening and degeneration of the proper textures of the part and of the arteries. The treatment is local stimulants, friction, and pressure; the ceratum hydrargyri compositum is a useful application.

VI. FEVERS.

Though the fevers which complicate operation-wounds have their origin in local changes, their destructive effects appear chiefly in the systemic circulation. Frequently as fever is met with, it is not an essential accompaniment of wounds as such, but is always an accidental affection; it may be developed at any time from the reception

[1] Sir J. Paget.

of the injury to the healing of the wound.[1] Its presence must therefore be regarded as a complication indicating changes other than those which are required in the simple act of healing. As a rule, in those cases in which fever appears, it begins on the second day and continues until the seventh; if an operated patient is free from fever at the expiration of the fourth day, he will probably remain without fever.[1] As the etiology of these fevers is not well understood, the terms used to designate them are vague and unsatisfactory; but as they are familiar it is desirable to employ them, with such restricted and well-defined meaning as will give them the greatest practical significance. The following classification of the so-called fevers which may occur after operation wounds is more nearly in accordance with the present accepted views of their causes and pathology.

1. **Traumatic fever**, which ordinarily includes the febrile affections following injuries and operations,[2] may be limited to that increase of bodily temperature due to the immediate effects of the operation, or traumatism. The shock of the operation is often followed by excessive reaction, with elevation of temperature not unlike inflammatory fever. The pulse and respiration become more rapid, the former in a greater ratio than the latter, particularly when there has been much loss of blood; the pulse is also generally fuller and harder; the skin is flushed and feels hot; thirst is increased and appetite lessened; the water of the urine is diminished; the bowels are inactive; the tongue usually white-coated, large, and moist; the sleep short and often disturbed; the elevation is variable, and bears no definite proportion to the severity of the injury, or, so far as is yet known, to any of the events connected with it; not rarely it subsides within twenty-four hours.[3] The treatment should be preventive, by guarding against its causes, namely, loss of blood, narcosis, exposure to cold and shock.

2. **Inflammatory fever**[4] appears with those changes in the wound recognized as peculiar to inflammation, and results from the local production of heat through textural changes by which the temperature of the entire mass of blood is gradually elevated. The absorption of particles of dead tissue may, even at this early period, be one element in causing a rise of bodily heat.[2] The presence, intensity, and duration of this fever depend upon the presence, intensity, and duration of the inflammatory process; it may, therefore, be absent, or slight, or severe. When present, the patient feels hot, or alternately hot and chilly; his skin, lips, and mouth become dry; the urine is less and less in quantity, and of higher color; the pulse is quickened, tongue dry and furred; there is thirst, restlessness, intolerance of disturbance, face flushed and anxious, troubled sleep,

[1] E. Wagner. [2] T. Billroth. [3] Sir J. Paget. [4] J. Simon.

or delirium. It lasts from one to seven days, the highest temperature being reached upon the first or second day, and seldom from the third to the fifth days.[1] Relieve the wound of tension by removing dressings, sutures, or collections of fluid which cause undue irritation; cleanse the wound with carbolized solutions, 1 to 40; make cold applications to the part, if they are tolerated; give cooling drinks; use sponging with cold water, and aconite to depress the heart's action.

3. **Septic fever**, septicæmia, is a constitutional, generally acute disease, due to the absorption of various putrid substances into the blood,[2] such as the putrid and toxic products of decomposing pus and blood, and the exudative detritus of gangrenous marrow.[3] Deep wounds, and those involving bone, in the course of which decomposition of the extravasated blood, stagnant pus, and gangrenous tissues occur, are the more frequent sources of the poison of septicæmia.[1] These fluids are highly charged with organic germs, bacteria, which seem to have a causative relation to their destructive effects. The chief factors in the production of the putrescent fluids of wounds are (1) the formation upon the wound of putrid substances, or septic poisons; (2) debilitating influences, as fatigue, loss of sleep, alcoholic habits, exposure to cold prolonged several hours after injury; (3) atmospheric agencies created by the crowding of the sick, or the presence of putrid emanations.[3] The poisons, or miasma, which vitiate the air must be regarded as the dust-like dried constituents of pus, and possibly also accompanying minute, living, and active organisms, which are suspended in the air of badly-ventilated sick-rooms, where patients are carelessly attended and there is deficient cleanliness.[2] These causes may act singly or together, but as soon as the blood has become altered by its infection, and the fever has declared itself, the suppuration, instead of remaining local, becomes generalized.[3] The pathological changes are not characteristic, and no metastatic abscesses are present.[1] Septic fever usually appears two to four days after the injury; the wound often does not suppurate, but discharges a thin, bloody secretion, occasionally containing air-bubbles; in its vicinity very extensive inflammatory œdema occasionally develops within a few hours or days; the skin is of a peculiar reddish-brown color; the constitutional disease generally begins quickly, usually without chills.[1] Its grade will depend upon the quantity and quality of the absorbed fluids; it may have the severity only of a febricula, scarcely recognizable from the ordinary inflammatory fever of wounds, or it may have a distinct onset, with well-marked stages throughout; or, finally, it may overwhelm the patient suddenly, like the severest diseases from blood-poisoning.

[1] E. Wagner. [2] T. Billroth. [3] L. Gosselin.

The symptoms[1] develop as follows: patients are apathetic or sleepy, if not comatose; occasionally there is excitement, and even maniacal delirium; the fever at first rises high, but later the temperature falls to the normal or even below it; chills are very rare at first, and never occur in the course of the disease; the tongue is dry, often hard, interfering with speech; there is thirst, but patients are too apathetic to drink; there may be profuse diarrhœa, rarely vomiting; at first there may be great sweating, but later the skin is dry and flabby; the urine is scanty, concentrated, and occasionally albuminous; urine and fæces are finally passed in bed; usually the patient dies in perfect collapse, with a thread-like and very frequent pulse. In the treatment, three indications are prominent: (1) removal from the wound of all septic matters, that no more may enter the circulation; accumulating fluids must be drained off, every cause of irritation removed, and thorough disinfection of all parts of the interior with bromine, or a solution of carbolic acid, frequently practiced; (2) support of the vital powers until the absorbed poison is eliminated; nourishing food, stimulants, quinine and iron, liberally, are the most useful; (3) change of the patient's location to secure better surroundings; if the weather permit, remove him to the lawn, or balcony, but if this is not practicable, change his room for one having abundance of fresh air and sunlight.[2]

4. **Pyæmic fever,** pyæmia, in its restricted meaning, has its source in venous thromboses which do not organize, but undergo a simple and more frequently putrescent softening, caused or at least favored by ichorous suppuration around the vein; emboli, produced from such thrombi, go from the right heart into the lungs, and become impacted in medium-sized and small arteries, or even capillaries, and cause metastatic abscesses, owing to their putrescent nature; they may reach the kidneys, spleen, liver, and other vascular organs.[3] The symptoms usually set in suddenly, with a severe chill lasting several minutes to an hour; the temperature rises from 102° F. to 105° F. in a few hours; the chills recur during the first days, usually daily, rarely regularly, at times even several chills a day; less frequently they are entirely absent; the chill is followed by intense heat, and then profuse perspiration sets in; the skin may be dry or damp, occasionally is covered with sudamina, later becomes more or less icteric; there is loss of appetite, great thirst, thickly coated and frequently dry tongue, and often painless diarrhœa; the face is haggard; there is general bodily and mental depression, and frequently headache; the organs affected with metastatic inflammation exhibit only moderate symptoms, and they are most marked when the respiratory organs and joints are affected; in

[1] T. Billroth. [2] L. Gosselin. [3] E. Wagner.

the recent wound there is rapid decay of the injured tissues and intense inflammation of the surrounding parts, while in the granulating wound the secretion usually diminishes, pus becomes thinner, ichorous; or the wound bleeds, is painful, and granulations become smaller and flabby; the surrounding parts are œdematous, the veins and lymphatics give signs of thrombosis and inflammation, and the entire limb occasionally appears remarkably withered; death usually occurs after an acute course, lasting one or two weeks, more rarely a subacute, and still more rarely a chronic course, in which the chills decrease in number and intensity; recovery is extremely rare.[1] The treatment should be pure air, cleanliness and disinfection, nutrition and stimulants. The patient must be removed to the open air and sunlight, if practicable; the wound must be disinfected with carbolized solutions, and kept perfectly clean, and the most nutritive and easily assimilable foods, as milk, beef-juice, should be given, with stimulants, and quinine and iron as tonics should be administered in as liberal quantities as can be borne. Amputation and disarticulation in acute septicæmia and pyæmia rarely have a permanently beneficial effect, but when these affections become chronic amputation may save life.[2]

5. **Hectic fever** is a continued fever, remittent, having great differences in the morning and evening temperature of the body, and is due to the constant absorption of the products of inflammation, especially of disintegration; it is most frequent and most intense from rapid breaking down of the inner wall of large abscesses, and progressive ulceration.[2] It is always preceded by indisposition, and may begin suddenly with severe rigors, though generally it creeps on gradually and stealthily; the exacerbation is usually in the afternoon, lasts six to nine hours, then gradually passes off to reappear about the same time the next day; there may be two paroxysms in twenty-four hours; the chill may be long and severe, the patient occasionally shivering for hours, or the sensation of cold may be very slight and its duration variable: the chilliness is followed by reaction, usually violent in proportion to the previous depression, gradually merging into a profuse sweat, with tranquil and refreshing sleep; in the interval the pulse continues frequent and easily excited; the face is pale, shrunken, and careworn; emaciation begins early, and is progressive; the tongue is generally clean, often red at the tip and edges, or smooth and glossy; the appetite is good, often voracious, and though digestion continues, assimilation fails; there is coldness of the limbs, but the hands and feet are dry, hot, and burning; as the disease progresses, emaciation increases, the pulse daily loses power, sweating is more profuse; bowels often loose;

[1] E. Wagner. [2] T. Billroth.

evening exacerbation, with chilliness, is more severe, and morning remission more marked; still later, all the symptoms are aggravated, the appetite begins to fail, aphthous spots occur on the tongue, œdema appears about the ankles and feet, chills and sweats which are colliquative succeed each other at shorter intervals, emaciation reaches an extreme degree, bed sores form, the mind continues clear until near the close, when unconsciousness supervenes.[1] The first requisite in treatment is to relieve the system of the exciting cause, as by disinfecting and destroying the internal surface of open abscesses; or by their removal with the knife, as the exsection of a carious joint, or the amputation of a limb affected with an incurable source of suppuration; the second indication is to sustain the patient with tonics, as quinine and sulph. acid, given in anticipation of the evening exacerbation, muriated tincture of iron, or other form, with wine, brandy, wine whey, ale, or porter; give easily digested and assimilated foods, as milk, eggs, meat-juice; finally, secure fresh air and perfect cleanliness.[1]

VII. NERVOUS AFFECTIONS.

Affections of the nerves and of the nervous system following wounds are frequently troublesome and even dangerous complications of operation wounds.

1. **Pain**,[2] other than that which is excited by inflammation, foreign bodies, improper dressings, and wrong posture, may complicate wounds. It may appear (1) only as an exaggeration of the ordinary pain of wounds, severe and abiding long, through personal sensibility and so-called nervousness, and is usually continuous with the immediate pain of the wound, or commences not more than an hour or two after it; (2) in some cases a wound is the beginning of a long-continuing neuralgia in or near the injured part; or (3) it is due to partial division of a nerve, or (4) the confinement of effusions under dense fasciæ. For the first form, hypodermic injection of morphia, or ice bladders, or opium, in full doses, are proper remedies; the second generally resists all treatment, even section of the nerve; the third requires complete division of the nerve; the fourth is relieved by enlargement of the wound.

2. **Spasms** of the muscles[2] are frequent complications, especially of amputation and resection wounds; the startings of the limb are often among the most distressing symptoms; they occur as the patient falls asleep and the influence of the will on the muscles ceases, and the pain remains until the muscles are at rest; at any time, uncontrollable quiverings and tremblings of the muscles may ensue, and lead to painful spasms. The remedy is posture and rest of the

[1] S. D. Gross; J. Croft. [2] Sir J. Paget.

wounded part, sustained by splints, or other appliances, and assisted by opium or other anodynes.

3. **Delirium tremens**, following injuries, and surgical operations on drunkards, or on persons of intemperate habits, is due to shock and its reaction, and the deprivation or stinting of stimulants which induce a peculiar impairment of the essential elements of the nervous structures.[1] The symptoms usually appear within two or three days after the operation; at first the patient is restless, sleepless, and talkative; then he has hallucinations and illusions of sight and hearing, which lead to attempts to get out of bed and escape reptiles and vermin, and to answer imaginary calls; next there is trembling of the tongue, hands, and limbs; the skin is moist and cool; the temperature normal; the tongue coated; the breath offensive; the eyes suffused. As the condition is one of debility, the great object of treatment is to enable the patient to take and to assimilate a sufficient quantity of proper nourishment.[2] The aim should be to fortify and stimulate the functions of the brain; mild preparatory purgatives may be required for the young and robust, but the debilitated must be sustained from the first; the typical stimulant is easily digested food,[3] and it is imperative that it be given regularly and continuously; the most desirable foods are milk with lime-water, soup or broth with bread in it, raw eggs beaten up, concentrated meats; irritation of the stomach requires ice, soda water, and other aerated drinks; the narcotic stimulants are useful, of which opium and cannabis indica are most valuable; opiates may always be administered in the form of morphia hypodermically injected in the dose of $\frac{1}{16}$ to $\frac{1}{4}$, or $\frac{1}{2}$ a grain; if the circulation is enfeebled, ext. cannabis indica should be given in doses of $\frac{1}{4}$ to $\frac{1}{2}$ a grain; alcohol should not be given to young subjects, nor in any case where it can be dispensed with.[3] In some cases it may be found necessary to give good ale, porter, or wine, with solid food.[2] Bromide of potassium combined with the hydrate of chloral, the former twenty to thirty grains and the latter ten to fifteen grains at a dose, is a valuable remedy in quieting nervous agitation. Restraint should be made by an attendant and not by confinement with cords or straight jacket.

4. **Delirium nervosum**[4] is allied to delirium tremens, but the trembling is absent; it is a state of excessive nervous exaltation, without fever,[5] occurring after injuries or operations attended by severe shock or loss of blood. It generally appears quite suddenly, within the first twenty-four or forty-eight hours after the application of the exciting cause, and rarely lasts more than five or six days; it may appear at a later period as a result of exhausting suppuration,

[1] J. Croft. [2] A. W. Barclay. [3] F. W. Anstie. [4] Dupuytren.
[5] T. Billroth.

and may even recur. The symptoms are confused, wandering, or flighty state of mind: excessive vigilance; incoherency of speech and manner; absence of fever; moist skin; quiet pulse; indifference to pain; wild expression of the eyes; intolerance of light, noise, and the presence of attendants; poor appetite; costive bowels; scanty urine.[1] The treatment should be sustaining and tranquillizing; mechanical restraint may be required; remove every source of irritation; correct any derangement of the digestive organs; give nourishing food and tonics; administer morphia hypodermically.

5. **Tetanus** is a spasmodic affection of the muscles, due to irritation of the spinal medulla and portio minor of the fifth pair.[2] The chief causes are cold and damp, and the injury of the operation.[3] The muscles of the jaw alone may be affected, trismus, or other groups may be involved. The symptoms appear as late as the third or fourth day after the injury, often later. In a well-marked case they develop in the following order: (1) there is a sense of suffering from a cold, with sore throat and stiff neck, an uneasy sensation and stiffness of the muscles of the lower jaw and tongue, rigidity of the back of the neck; (2) difficulty and pain in masticating and swallowing food, fixed and closed state of the lower jaw, severe pain with every effort to open the mouth; (3) convulsive cramp in all the affected muscles on any attempt to swallow; (4) sudden, violent, and continued pain, increased at short intervals by spasm extending from the ensiform cartilage to spine in the situation of the diaphragm; (5) constricted and hardened state of the abdominal muscles, giving the sensation of a board to the hand; (6) all of the voluntary muscles become involved, the head is thrown back and fixed, the extremities become fixed and rigid, the shoulders are drawn forward, the countenance is pale, anxious, and contracted, and disfigured with the tetanic grin; (7) the spasms become more and more frequent and violent, with hurried and laborious respiration, and quick, small, and irregular pulse; (8) the spasms may not be sudden, but may gradually draw parts into the form of a bow; (9) at the close the whole face becomes distorted and disfigured, the larynx forcibly drawn up, and in the majority of instances the case terminates in a paroxysm of spasm; (10) the intellectual faculties remain unimpaired.[4] The bodily temperature varies greatly in different cases. The treatment can be only symptomatic, owing to the uncertainty as to its etiology; the most marked indication is to alleviate the acute course, and make it more chronic: narcotics with opium and chloroform are most often employed, the former in large doses as by hypodermic injections of morphia, and the latter during the spasm;[2] the opium never removes the cause, though it will prevent

[1] S. D. Gross. [2] T. Billroth. [3] C. B. Radcliffe. [4] Morgan.

the effects, and does good by not allowing the symptoms to do harm.[1] The Calabar bean has proved more useful, perhaps, than other remedies, when given in such doses as to paralyze the voluntary muscles.[2] Almost every other internal remedy has been successively tried, but no one individual medicine has proved an appropriate means of cure; they have been useful only as they have rendered the paroxysms less severe, and enabled the patient to resist the exhaustion caused by spasmodic action. It must be remembered that the disease will run a certain course, having its period of accession, its height of intense activity, and its gradual decline; nothing seems to check its progress, or control its unvarying and too often fatal career; all that can be done is to give the patient as much strength as possible, to avoid all useless applications and internal remedies, and all exposures to excitement and cold, and to watch day and night in order to protect and sustain him.[3]

CHAPTER XI.

THE CICATRIZATION.

Though the morphological changes are the same in wounds healing by first and second intention,[4] it is in the open wound, healing by granulation, that the several steps of the normal process, and the various complicating affections, may be most advantageously studied.

I. NORMAL CICATRIZATION.

The growth of granulations and of vessels going on beneath the suppuration reaches its physiological limit when they have arrived at the level of the surrounding skin; when this is attained, suppuration diminishes, and the formation of the epidermic covering, the skinning over, commences from the borders.[5] In association with shrinking of the vessels and of the tissue of the granulations containing them, the superficial extent of the wound diminishes, and at the same time the skin surrounding it becomes drawn towards the centre; at the part where the skin and granulations meet, the secretion of pus becomes somewhat diminished, first a dry, red border about one and a half lines in breadth forms and spreads towards the wound, and in proportion as this advances and covers the granulating surface, a clear, bluish-white border follows immediately after it, and is transformed into epidermis.[4] This bluish-white border, advancing from the edges of the wound towards the centre, is made up of young epidermis which allows the subjacent blood-vessels to shine

[1] J. Hunter. [2] E. Watson. [3] A. Poland. [4] T. Billroth. [5] M. Kaposi.

through its thin layer with a bluish tint; at last the whole is covered with epidermis, consisting at first of mere polygonal, less flattened, and nucleated cells, which are frequently shed; later they appear more flattened, are in thicker layers, and have a longer duration; the scar, therefore, assumes a bluish tint so long as it is young; later, in proportion as the epidermic layers covering it become thicker, and a greater number of its vessels and those situated at a greater depth shrivel up and become obliterated, it appears whiter, smoother, and shining; the scars continue to contract for many months and years.[1] The rate of healing is ordinarily half an inch per week, those wounds healing most rapidly which correspond with the long axis of the body.[2]

The subjective sensations caused by the granulations during normal cicatrization, as well as by the fully formed scar, are inconsiderable; healthy granulations possess a certain degree of sensitiveness to external irritation, and to the touch in particular, but this is far from being painful; diminished or increased sensitiveness are therefore indications of an abnormal course; at the commencement, and in the course of the cicatrization of wounds of the skin, an itching sensation is often experienced in the immediate vicinity, which, however, has no prognostic value; completely formed scars are normally not at all specially sensitive, though stretching or mechanical irritation of any kind may make them painful. Many persons complain of drawing, tearing, pricking, radiating pains occasionally felt in scars, which they connect, without cause, with changes in the weather.[1] In normal cicatrization, the following indications of treatment should be carefully attended to at every stage: (1) the granulations must be protected from every possible source of irritation, as too frequent change of dressing, too much movement of the part, filth, retained secretions; (2) the granulations should never be broken so as to bleed, for such lesions are liable to be followed by the absorption of septic ferments;[3] (3) the direction and shape of the cicatrix should be so moulded or shaped by the dressing as least to impair the function and symmetry of the part.[4]

II. DISEASED GRANULATIONS.

The granulating surface is liable to undergo many changes which modify the process of cicatrization. The formation of the epidermis may thus be interfered with, or the epidermis alone may suffer delay or interruption.[1]

1. **Erethitic granulations**[5] are characterized by great pain on the slightest provocation; are very proliferous, and readily bleed;

[1] M. Kaposi. [2] G. W. Callender. [3] J. Lister. [4] G. J. Swerchesky; Langer. [5] T. Billroth.

occasionally they are so sensitive as not to endure the slightest touch, nor any dressing, but a less degree of sensitiveness is more common. The cause is uncertain, but may be due to a peculiar degeneration of the ends of the nerves at the floor of the wound. The remedies are soothing applications, almond oil, spermaceti ointment, poultices of linseed meal, or warm-water compresses; narcotic applications are of little benefit. If these applications do not succeed, the entire granulating surface, or at least the painful part, must be destroyed without delay by caustics, as nitrate of silver, caustic potash, or the hot iron, or by excising the entire surface with the knife, the patient being anæsthetized; if hysteria or anæmia exist, tonics, as iron and quinine, remedies which relieve general irritability, valerian, asafœtida, should be employed.

2. **Croupous granulations**[1] form a yellow rind on part of the surface, readily detached, and composed of pus cells very firmly adherent to each other. The membrane re-forms even a few hours after its removal, and this is repeated for several days, till it either disappears spontaneously, or finally ceases on cauterization of the affected part. If disease of the granulating surface be accompanied by swelling, great pain, and fever, there is a true, acute inflammation of the wound, which usually ends in sloughing of the diseased granulations. The treatment is purely local; any causes of new irritation should be sought out and prevented; the fibrinous rinds should be daily removed, and the exposed surface cauterized with nitrate of silver, or painted with tincture of iodine.

3. **Indolent granulations**[2] may become completely papillary, and form a flat surface, which, instead of being vividly colored, is of a brownish-red tint, finely granular, secretes a little thin serous pus, and frequently, owing to drying up of this secretion, appears as if smeared over with varnish, dry, glistening, and iridescent; or the surface of the wound has a shining, oily appearance, or its upper layers break down into a fatty, greasy pulp; in this indolent condition the wound may remain for weeks or months without markedly altering its level, and without cicatrization taking place from the periphery inwards. Or the granulations, having shot forth luxuriantly, may be easily lacerated, bleed freely and frequently; hæmorrhagic effusion takes place into them, by which they become of a bluish-red color, degenerate, shrivel up, decay into shreds, and are cast off; or the abundant granulations are dropsical, soaked with fluid, of a pale rose tint, and transparent. Such granulations do not favor cicatrization, as they do not afford a sufficiently firm support for the advancing border of epidermis, and are easily destroyed. This condition of the granulations occurs more often in persons of im-

[1] T. Billroth. [2] M. Kaposi.

paired nutrition from whatever cause, as anæmia, cachexia, scrofula; or if suffering from febrile excitement; or it may be due to local irritation of the wound, as pressure, friction. Indolent, torpid granulations may be excited by slightly stimulating applications, as unguent basilicum, or slightly caustic remedies; in obstinate cases it is advisable to destroy the whole surface of the wound down to the healthy tissues by means of some energetic caustic, as the hot iron, nitrate of silver, chloride of zinc, caustic potash, so as to secure a more active formation of granulations from healthy tissues; swollen granulations, about to become disorganized, may be advantageously destroyed, to a certain depth, by the same means. Additional remedies are slight cauterization frequently repeated; dusting on powdered alum; painting with a concentrated solution of nitrate of silver, or applying the solid stick; an ointment containing two grains acetat. copper to the drachm; or a lotion of caustic potash, one or two grains to the ounce of distilled water; or an ointment of red precipitate, two or three grains to the drachm, or of nitrate of silver, thirty grains to the ounce. After the surface of the wound has been freed from any dead, gangrenous, diphtheritic, or hæmorrhagic coating, and granulations are seen springing up everywhere, we have a valuable addition to our means of treatment in the transplantation of epithelium and portions of skin.

The procedure[1] is as follows: The more healthy the granulation the more certain is success. It is not material from what point of the body the graft is taken, but it will be found most convenient to take it from some portion which is thin and flexible, as the sides of the chest and the front of the legs and arms. The best and simplest method of taking the graft is with the point of a common needle to raise the integument, and with the knife or scissors cut out a small piece of true skin, without adipose tissue; there need be no bleeding. As the pieces should be very small, subdivide those taken several times; lay these fragments upon the granulations with the raw surface downward, when practicable, though this position is not absolutely necessary; place the first near the margin, and the remainder about one inch apart, as this is the ordinary limit of their growth; cover them with common adhesive strip and bandage, or apply oiled gutta-percha skin, or the antiseptic dressings. Keep the part at rest for three days, when the dressings are to be very carefully removed, and the sore made clean with tepid soaped water applied with a stream; the surface should not be rubbed. The subsequent treatment is that of an ordinary ulcer. When the dressings are first removed, what appears to be the grafts may be seen lying where they were originally placed, or floating loosely about; sometimes they have disappeared altogether. On the seventh to the tenth day there is a bluish-white opaque appearance at the seat of the successful graft, which indicates skin

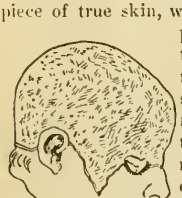


FIG. 47.

[1] F. H. HAMILTON; M. Reverdin.

formation. At the same time there is a projection of new skin from the margin of the ulcer towards the nearest graft, which finally forms a bridge, and the graft is lost in the surrounding integument, and becomes in its turn the outer margin of the greatly diminished ulcer. Finally, all the grafts coalesce, each contributing an inch or less to the completion of the cicatrization.

By grafting, the most extensive open wound, as complete denudation of the head (Fig. 47), a wound which could not by any other method be completely healed, rapidly cicatrizes around its whole margin (Fig. 48), and becomes in no considerable time firmly repaired.

FIG. 48.

4. **Exuberant granulations**[1] exist when they rise above the level of the skin, and lie over the edges of the wound like fungus. They are usually very soft; the pus secreted is mucous, glairy, tenacious, contains fewer cells than good pus, and most of the pus cells, like granulation cells, are filled with fat globules and mucous material, which is also more abundant than normal as intercellular substance. The development of vessels may be very prolific, and the fragile tissue often bleeds on the slightest touch, but occasionally the granulations are of a very dark blue color; in other cases the development of vessels is very scanty, the surface light red, or in spots even has a yellowish, gelatinous appearance in anæmic persons, and the young and old. The cause of proliferating granulations may be a foreign substance in the wound, rigidity of surrounding skin, large wounds which contract slowly. Cicatrization will not progress properly until the granulations have been brought to the level of the skin.

For this purpose, the daily application of nitrate of silver along the edges, and its repetition when the white slough which it forms separates, is very useful; also powdered red oxide of mercury sprinkled daily on the surface. Astringent lotions, as decoction of oak or cinchona bark, and lead water are useful where the proliferation is less; compression with adhesive plasters acts well occasionally. If the granulations are exceedingly dense and large, they may be cut off with scissors, the bleeding being arrested by charpie.

III. THE CICATRIX.

There are many variations in the cicatrix which have a morbid condition or tendency, and require care and treatment.

1. **The Defective cicatrix**[2] remains thin, weak, vascular, moist, easily breaking out, and yielding so as to expose the subjacent structures; it indicates a failure or incompleteness in the last stages of healing, a deficient development of cuticle, and too little contraction of the granulations or bond of adhesion. Such scars are most frequent after

[1] T. Billroth. [2] Sir J. Paget.

wounds healed by granulations that have become œdematous, soft, and puffy, whether through disease or the constriction due to the contraction of tissues healing round them; they are common after wounds that heal slowly, and in weakly patients. Such scars are prevented by cauterizing exuberant and œdematous granulations with nitrate of silver or sulphate of copper, and dressing them with solutions of those, or other astringent lotions.

Similar solutions are useful for the scars themselves, as also the bichloride of mercury in spirit. Scars should always be warmly and dryly covered, as they are sensitive to cold, and this protection may be required for many months.

2. **The exuberant cicatrix**[1] presents various forms in its frequent combinations, with their indurations and degeneracies. In its simplest condition, it appears only as a thick or lumpy scar, which projects from the surface instead of being plane or depressed; it sometimes follows the operation for hare-lip, and here shows its worst quality, as it is unsightly and apt to contract long after its formation. Similar scars occur after vertical wounds through the eyelids. These scars cannot always be avoided, for they are sometimes due to constitutional defects, as in scrofulous persons; but when their deformity would be troublesome, the most scrupulous means should be adopted to obtain immediate union of the wound. When they are formed, the absorption of the lowly organized new structures, of which the scars are composed, is best promoted by the repeated application of stimulants or vesicants, as the strong solution of iodine, or blistering fluid.

3. **The adherent cicatrix**[1] adheres too much and too long to the adjacent structures, and thus falls short of that stage of improvement in which there is a gradual loosening of the tissue, a part of the normal process, which at first unites a scar to the parts beneath or near it. The persistence and excess of scar-tissue existing in the failure of this loosening process are often grave inconveniences, either from deformity, or by rendering the scars liable to ulceration, or by interfering with their nutrition. The relief of this condition is difficult; the best means are friction, shampooing, steaming, and, if the tissue is abundant, stimulants or vesication; but all remedies must be used very gently when the scar adheres to bone.

4. **The contracted cicatrix**[1] may follow any wound, but is most frequent in those which involve strong fasciæ, and after deep burns; in some cases the scar appears only to contract, but in more it becomes very dense, hard, toughly fibrous, nodular, and lumpy, and usually adheres closely to the structures near it. The certainty of considerable contraction of the scar of a wound healed by adhesion or granulation, and the possibility that it may be excessive, must be regarded in every surgical wound involving parts in which contrac-

[1] Sir J. Paget.

tions would be mischievous. The length of a wound should, if possible, be in that direction in which subsequent shortening will be least important; and it may often be necessary to make provision against contraction of scars by lateral or other incisions, or by plastic operations. When no provision can be made, the healing must be carefully watched, and some elongating force must be applied in the direction to counteract the contraction; if near the joints, the tendency to contraction must be overcome by splints with screws, or elastic bands or cords, whose persistent recoil after being stretched will exercise a force more powerful and not less constant than that of the scar. Elongation may be assisted by frequent application of moist heat, or shampooing, and other means of softening and causing partial absorption of the scar-tissue; the treatment must be continued as long as the disposition to contract exists. If the contraction finally impairs the function of a part, it may be necessary to dissect out the cicatrix and transplant healthy skin to the wound.

5. **The painful cicatrix**[1] is most common after amputation, but may occur in the scar of any wound. The cause of the pain is often obscure, and the more so owing to its commencement in some cases a long time — it may be years — after the healing of the wound, and without visible change in the scar. But in stumps it is nearly certain that the pain is due to a morbid condition of the ends of one or more of the divided nerves; not to the bulbous swelling common in the healing of nerves, generally painless, but to morbid adhesions of the nerves to the end of bone or to skin, so that they are kept in constant irritation, or are inflamed. In other cases no such condition can be found, and the cicatrix can only be called neuralgic. When the pain of a scar depends upon adhesions or other such morbid condition of the nerves, subcutaneous division may be practiced;[2] when wounds have been allowed to heal with the limb bent, or otherwise misplaced, the neuralgia seems to be due to compression, and recovery follows restoring the normal movements with douche and friction.[3] When these measures fail, or the case is one of obscure and severe neuralgia, the treatment must be that of ordinary neuralgic affections, namely, quinine, belladonna, and other narcotics, the local application of anodynes, or excision.

[1] Sir J. Paget. [2] H. Hancock. [3] S. W. Mitchell.

II.

THE OSSEOUS SYSTEM.

THE BONES; THE JOINTS.

CHAPTER XII.

THE INJURIES OF BONES.

Violence applied to bone results in lesions analogous to those produced by the same causes on the soft tissues. Contusion may be followed by the inflammatory process, and the results appear among the diseases of bone. Fracture is the counterpart of the wound of the soft tissues and demands immediate care, either in operative procedures or in the employment of adjusting and retaining appliances. This lesion is divided, for practical purposes, into (1) the Simple Fracture, (2) the Compound Fracture, (3) the Shot Fracture.

I. SIMPLE FRACTURE.

Endeavor,[1] on first approaching a patient suffering from fracture, to inspire him with a confidence that he is not to be unnecessarily hurt; sit quietly beside him, and inquire minutely into all the circumstances relating to the accident; remove the clothes from the injured limb with the utmost care; notice its position, contour, points of abrasion, discoloration, or swelling; pass the fingers lightly along the surface of the limb, pressing more firmly at points where there are appearances of injury; finally, to solve all doubts, grasp the limb so as to make traction of the lower fragment, rotate to obtain crepitus, and make lateral motions to indicate the false point of motion; in the application of the necessary dressings, let gentleness and a manifest regard for the patient's sufferings characterize every act; and, throughout the subsequent treatment of the case, proceed slowly, thoughtfully, and systematically, for rude and

[1] F. H. Hamilton.

awkward manipulations, by which pain is needlessly inflicted, are frequent sources of inflammation, suppuration, and gangrene.

In the simple fracture the bone is broken at a single point, the lesion is subcutaneous, and no other important parts are involved: it is therefore in the most favorable condition for repair.

The signs of fracture, on which reliance can be placed, are: (1) crepitus, obtained by rotating the lower fragment; (2) preternatural mobility, produced by lateral movements of the fragments; (3) spontaneous displacement when reduction of the fragments has been effected. The treatment is replacement of the fragments, and maintenance of their extremities in apposition. Replacement should be effected as soon as possible after the accident.[1] The fragments may usually be placed in coaptation by extension and counter-extension with the hands; but should such means fail, anæsthetics must be used, and even pulleys.[2] Maintenance is accomplished by side or coaptating splints, by long or extending splints, by the weight and pulley, by plastic apparatus, or by a combination of these methods. Of the several appliances, the plastic apparatus, in its various forms, most effectually secures and maintains coaptation, but used as a bandage when the fracture is accompanied with such injury to the soft parts as to render subsequent inflammation inevitable or probable, this form of dressing exposes to congestion, strangulation, and gangrene.[1] As safety in the use of this dressing depends much upon the skill and care of the surgeon, the rule should be never to resort to it unless familiar with all its peculiarities, and in a position to give the case necessary care.[3] When employed, the provisional callus will always be less, and hence firmness will result later, yet the formation of definitive callus will not be disturbed.[2] But these objections do not apply to the different forms of gypsum splints,[4] which can be readily and perfectly adapted to support the limb and not endanger it by strangulation; these splints should be applied in the first stage of the case; swelling from contusion and subcutaneous laceration, uncomplicated with lesion of the vascular trunks, is not an objection to the immediate application of the apparatus; on the contrary, the support and enforced rest have a beneficial influence in controlling swelling and its consequent pain. As a rule, no bandage should at first be applied directly to the skin.[1] The dressings adapted to individual fracture must necessarily vary very much, but it may be stated as a principle applicable to each case that that apparatus is the best which, whilst it answers the indications equally well, exacts the least amount of skill and attention.[1]

1. **The inferior maxilla** may be fractured at any point of the body and of the rami, or two fractures may occur. Of the variety

[1] F. H. Hamilton. [2] T. Billroth. [3] A. C. Post. [4] J. Croft.

of apparatus constructed, the most convenient and serviceable in general practice is an interdental gutta-percha splint, moulded to the crowns of the teeth, and an external gutta-percha or sole-leather cap for the chin, held in position by the four-tailed bandage (Fig. 49).

FIG. 49

The following apparatus[1] is very permanent: Pass a firm leather strap under the chin, and buckle over the top of the head; stay it by two counter-straps of linen webbing; loop one of these upon the maxillary strap at a point just above the ears, and elevate or depress it for different heads; buckle this strap under the occiput posteriorly, and across the forehead anteriorly; pass a vertical strap over the top of the head in the line of the sagittal suture, and unite the maxillary and the occipital strap; to prevent the maxillary strap being displaced backward, fasten a chin-piece to it.

Union is complete in three weeks; non-union is very rare.[2]

2. **The ribs and cartilages** are more often fractured in advanced life; the displacement is usually very slight, and not easily overcome, but union takes place quickly, even when quietude is not secured.[1] Emphysema, due to injury of the lung, is quite common, and generally demands no special attention; but, if very extensive, it may be necessary to make an incision, or to open the wound down to the point of fracture, to allow the air to escape.[1] Union takes place in about one month.[2] The fractured rib may be efficiently maintained in a state of rest by the application of strips of strong adhesive plaster (Fig. 50) two inches broad, extending from the sternum to the spine, covering in the seat of injury and at least three inches of surface above and below it; each strip so applies as to overlap half of the preceding[2] (Fig. 50).

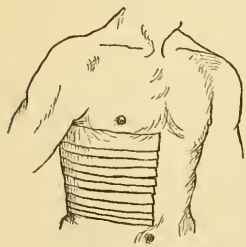


FIG. 50.[2]

If several ribs are fractured, they may be maintained in very accurate apposition by a broad band of adhesive plaster. Cut the plaster of a width equal to one half the depth of the thorax, and of sufficient length to extend once and a half around the body. Place the strip under the patient, while recumbent, so as to inclose the lower half of the thorax, the adhesive side internal, and while he is in the act of forced expiration pass one end firmly over the thorax and the other in the opposite direction over the first; there is now a sense of suffocation, which is soon followed by relief; the pain quickly subsides; do not change the dressing until the cure is complete.

3. **The clavicle** fractured is replaced by supporting the shoulder in an upward and backward direction. This position is most perfectly secured in the recumbent posture, with an unyielding pillow, broad, and long enough to cover the whole back of the chest, and

[1] F. H. HAMILTON. [2] T. BRYANT.

slightly inclined from above downward, allowing a somewhat greater elevation for the head and shoulders than for the loins or waist, the depth of the upper margin not being greater than eight or ten, and of the lower two to three, inches; this position need not be retained more than ten to fourteen days.[1] No apparatus completely maintains the reduction sufficiently long to insure a perfect union, but the following method secures all the advantages yet attained: Pass a sling under the elbow of the wounded side, and tie it to the opposite shoulder; insert a well-fitting axillary pad, but not so large as to be a fulcrum; apply a bandage around the body, so as to secure the elbow against the trunk.[2] (Fig. 51.)

FIG. 51.

The gypsum bandage[3] is useful where there is great difficulty in maintaining parts in good position (Fig. 52); apply the bandage over a stout flannel undershirt thus: place the arm of the affected side across the thorax, the hand well up towards the shoulder; standing in front, make several turns around the body below the arm from right to left, if the left clavicle is fractured, and *vice versa*; now pass one turn over the fore-arm, hand, and shoulder, and the next around the arm and body, and so alternate until the arm is completely enveloped. This dressing is entirely comfortable, and need not be changed.

Adhesive plaster[4] may be applied: Select strong adhesive plaster, and cut it into two strips three or four inches wide, but narrower for children: one should be of length to encircle the arm and the body, and the other to reach from the sound shoulder around the elbow of the fractured side and back to the place of starting. Pass the first piece around the arm just below the axillary margin, and stitch in the form of a loop sufficiently large to prevent strangulation, leaving a

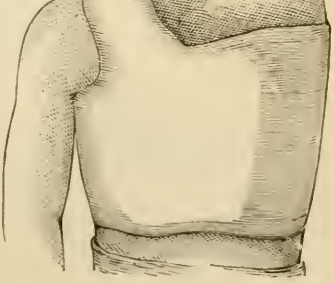


FIG. 52.

[1] E. Hartshorne. [2] F. H. HAMILTON. [3] *Bellevue Hospital Reports.*
[4] L. A. Sayre.

large portion on the back of the arm uncased by the plaster: draw the arm downward and backward until the clavicular portion of the pectoralis-major muscle is put sufficiently on the stretch to overcome the sterno-cleidomastoid, and thus pull the inner portion of the clavicle down to its level: carry the plaster smoothly and completely around the body, and pin to itself on the back to prevent slipping. This first strip of plaster fulfills a double purpose: first, by putting the clavicular portion of the pectoralis-major muscle on the stretch, it prevents the clavicle from riding upward; and, secondly, acting as a fulcrum at the centre of the arm, when the elbow is pressed downward, forward, and inward, it necessarily forces the other extremity of the humerus (and with it the shoulder) upward, outward, and backward. And it is kept in this position by the second strip of plaster, which is applied as follows: Commencing on the front of the shoulder of the sound side, draw it smoothly and diagonally across the back to the elbow of the fractured side, where a slit is made in its middle to receive the projecting olecranon. Before applying this plaster to the elbow, an assistant should press the elbow well forward and inward and retain it there, while the plaster is continued over the elbow and fore arm, pressing the latter close to the chest, and securing the hand near the opposite nipple; crossing the shoulder at the place of beginning, it is there secured by two or three pins.

Union occurs with great rapidity, sometimes as early as the seventh or tenth day, but the arm should be kept quiet two or three weeks.[1]

4. **The humerus,**[1] fractured at any point above the elbow, should be maintained in position as follows: Select a piece of leather, gutta-percha, or felt, long enough to extend from above the acromion process to the elbow-joint, and wide enough to inclose about one half of the circumference of the limb; mould it while wet to the outside of the arm, and allow it to become dry; prepare a short splint for the inside of the arm; cover each splint with a sack of woolen cloth; reduce the fracture and apply the splints to the arm with a roller bandage, and secure the arm to the body with a second roller bandage passed around the latter; flex the fore-arm, and suspend by a sling. No bandage is required for the fore-arm; slight overlapping may be anticipated. If the fracture is at or near the elbow-joint, the fore-arm must be placed and maintained at a right angle with the humerus by means of a thick piece of gutta-percha, moulded to fit the shoulder, arm, and fore-arm, and well padded; place the fore-arm at a

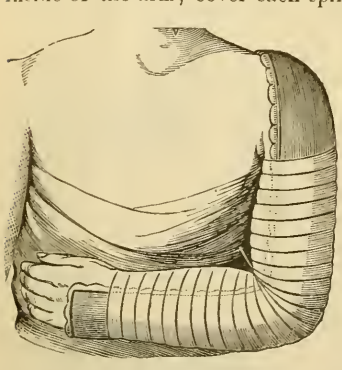


FIG. 53.

[1] F. H. HAMILTON.

right angle with the humerus, and maintain it in this position by a right-angled splint; cover the gutta-percha splint with a woolen or cotton sack, and secure it to the fore-arm by a roller. In a case of fracture of the humerus above the condyles, while extension is made secure the upper portion of the splint to the arm in a similar manner. The front or bend of the elbow should always be well covered with cotton batting before inclosing the elbow-joint in the turns of the roller, to prevent strangulation.[1] Passive motion must be commenced very early by loosening the dressing, supporting the parts at the joint, and making flexion and extension. If the fragments are not disturbed, repeat this manœuvre daily.[1]

5. **The radius** fractured above the attachment of the pronator quadratus must be so adjusted that the proper axis of the bone is maintained, to secure the restoration of its normal movements.[2] The elbow should be semiflexed, the fore-arm and hand, excepting the fingers, supported between a dorsal and a palmar splint secured by adhesive plaster; the limb should be accurately fixed in supination at an angle of 120° by means of angular pads; the thumb in this position is brought nearly into a line with the outer fleshy border of the supinator radii longus.[3]

Fracture of the radius within an inch of the wrist-joint[4] has received the following elucidation :[5] The fracture is caused by forced extension of the hand on the fore-arm, the bones of which constitute two levers, A and B (Fig. 54), held together by the anterior and posterior radio-carpal ligaments C and D.

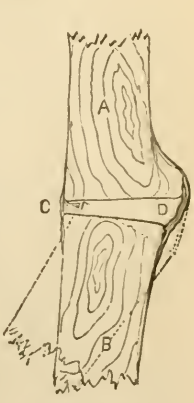


FIG. 54.

When B is forcibly carried backwards, as in extension of the hand, the band D is made tense; the opposite border of the lever, having slipped forward as far as the band C will permit, now abuts against the lower surface of A, which becomes a fulcrum for the further action of the lever. The mechanical arrangement is such that an immense power may be exerted; if the backward force continues to act, either the band D must rupture, or a lever be fractured; the projecting lip upon the upper lever puts it at a disadvantage; the band continues to sustain the strain, and the lever gives way (Fig. 55). The point of fracture is necessarily just above that portion of the lever controlled by the band; the strain upon the lever is nearly transverse. By the powerful leverage which the extended hand and carpus obtain through the strong anterior ligament upon the lower end of the radius, that portion of the bone is literally torn from it. A second force, other than that of extension, is also present, as an important and independent

[1] F. H. HAMILTON. [2] J. Packard. [3] G. W. Callender. [4] A. Colles. [5] L. S. PILCHER.

factor in the production of the results, namely, the forward and downward impulse of the lower end of the radius. A force compounded of the weight of the body and the velocity of the fall is received upon the anterior ligament, and converted by it into a force of avulsion. The new and final relation of parts (Fig. 55) is fixed by the periosteum covering the back and lower portion of the radius, reinforced by fibres from the posterior ligament and posterior annular ligament of the wrist. The force having expended itself, and the injured member being relieved from the weight, entirely new forces begin to act upon it. The hand recovering from the condition of forced extension, as it straightens or becomes flexed to the extent of its weight, tends to bring back with it the lower fragment of the radius; this fragment, abutting against the projecting posterior margin of the upper fragment *f* (Fig. 56), is supported as a fulcrum, and the result of the weight of the hand is simply to make still more tense the aponeurosis which is attached to it behind. Thus the characteristic deformity is produced and maintained, while immobility of the fragments and absence of crepitus is secured (Fig. 57). When the radius has given way, and the force of extension is no longer arrested by the insertion of the anterior ligament into its broad margin, this force is felt strongly by that portion of the ligament which is inserted into the ulna; the whole hand, with the lower radial fragment, is caused to move backward and outward, as in supination; a strong fasciculus of the anterior ligament, passing obliquely from cuneiform bone to anterior border and base of the styloid process of the ulna, bears the most of the strain; through it, the tendency to supination is increased, the rounded head of the ulna is made to project strongly upon the front and inside of the wrist, its styloid process becomes approximated to the radius upon the back of the wrist, and in some cases is completely torn off. In this position the parts are firmly held, all rotation in either direction being prevented, as long as the backward displacement of the lower radial fragment remains unreduced.

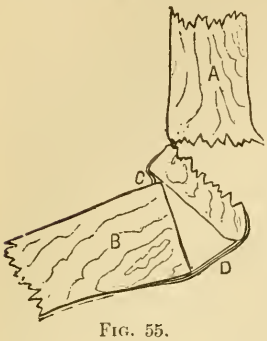


FIG. 55.

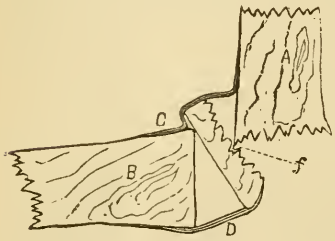


FIG. 56.

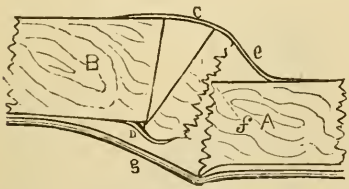


FIG. 57. *e*. Dorsal periosteal pseudo-ligament. *f*. Point of entanglement. *g*. Flexor tendons.

In the treatment,[1] two classes of fractures must be recognized,

[1] L. S. PILCHER.

namely, those without and those with displacement. The first is likely to be called a sprain and to be treated as such; for immediately upon the recovery of the hand from the over-extension which it had sustained, the corresponding surfaces of the fragments fall together, where they are held by the weight of the hand when prone; there is no tendency to displacement. The indications are: (1.) That the wrist should be supported in the prone position, with the hand hanging loosely, and thus maintain the fragments in apposition. (2.) That movements of extension of the hand should be limited, lest separation of the fragments again occur. The first indication in the treatment of the second form is to overcome the displacement, which is effected as follows: Bend the hand and wrist backward, approximating the position in which the parts were when the displacement took place, and relax the tense periosteum. Slight extension now in the line of the fore-arm is sufficient to disentangle the rough surfaces of the fragments from each other, and moderate pressure upon the dorsum of the lower fragment causes it to fall into line; the weight of the hand is now sufficient to secure perfect apposition of the fragments; the periosteum again envelops closely the whole length of the radius; the tense inner fasciculus of the anterior ligament is completely relaxed; the radio-ulnar movements are free; the head of the ulna has ceased to project as if subluxated; all the parts have resumed their natural relations; the fracture has become one of the first class, with this difference simply, that the sprain of the soft parts is much more aggravated. Splints are not always necessary in the treatment, but all the measures indicated as of value in overcoming the results of sprained wrist are now of importance; as compression and support by means of a bandage encircling the joint; the snug application of a strip of strong adhesive plaster, two inches wide, so as to grasp firmly the lower extremities of both radius and ulna, to restrict effusion, and reinforce the radio-ulnar ligaments, and render more tolerable efforts at motion of the wrist-joint; massage, early, persistently, and skillfully applied; motion, early, regular, and decided in character; use of the hand after the third day.

As a rule, it would not be wise to discard splints altogether in this fracture, but they may in general be limited to a single well-padded splint on the dorsal or palmar surface.[1] There are instances of great displacement and contusion, in which two light-padded splints, carefully applied with adhesive strips, are useful.

6. **The olecranon process** separated from the ulna requires the straight position of the fore-arm. Apply a light but firm splint, extending from about four inches below the shoulder to the wrist, wide as the arm at its widest part, thickly padded with cotton batting to

[1] F. H. Hamilton.

meet the irregularities of the arm, and having a notch cut about three inches below the olecranon; place it on the palmar surface, and apply a strip of adhesive plaster, the centre being on the process and the ends drawn firmly through the notches and fastened to the splint; retain the splint in position by a bandage or strips of plaster passed circularly around the limb and splint.

The plaster of Paris is applied as follows: Place the limb in extreme extension; cover it with cotton batting or flannel; apply three layers of bandage, and when it is hard cut out a large fenestrum over the olecranon; now apply strips of adhesive plaster, the centres being over the upper surface of the olecranon, and fasten the ends, drawn down firmly, to the sides of the splint (Fig. 58).

FIG. 58.

7. **The radius and ulna** fractured must be maintained in parallelism. Take two wooden splints of the length of the fore-arm, nearly or quite the width of the limb at its widest part, properly padded; apply them evenly to the palmar and dorsal surfaces, and retain them with two adhesive strips applied directly around the limb and splints.

8. **The femur**[1] is liable to be fractured through the neck, within and without the capsule, below the trochanter minor, in the central portions of the shaft, just above the condyles, through the condyles, and at the points of epiphyseal connections. Fracture of the neck, including even cases of suspected fracture, should be treated as if in a condition favorable to bony union, in order both to save the patient from the pain and suffering caused by the irregular contractions of the muscles, due to the pressure of the broken fragments against inflamed tissues, and to insure a longer limb and less eversion if bony union does not take place. Fractures of the shaft are generally oblique, and the fragments override from half an inch to two inches, owing to the contraction of the muscles; fractures just above the condyles are in most cases oblique from above downwards, and from behind forwards. All of these forms of fracture can be treated more successfully in the straight than in the flexed position, and in nearly all cases extension is more effectually made by the weight and pulley than by any other method. The sooner the limb is put up and subjected to this method of treatment after the fracture, the better; suffering is prevented, and the sufferer made comfortable from the outset.[1] Precisely the same form of apparatus is not suited to all fractures of the femur, but certain modifications are required to meet all of the indications present. In an ordinary case, provide a firm

[1] F. H. HAMILTON.

bed with a suitable mattress (Fig. 61); apply a roller bandage from the toes to the ankles; next apply strips of strong adhesive plaster two and a half inches broad, and well warmed, to both sides of the leg, extending from the fracture some inches below the sole of the foot (Fig. 59); warm the ends and lap them over each other so as to make a loop of two thicknesses four inches below the sole of the foot; in this loop put a foot-piece of wood four inches long and three inches wide; continue the roller bandage over the limb to the groin; pass a strong India-rubber band around the foot-piece in the depressions cut on either side, and attach to it a rope, or make a hole in the centre of the block, through which a cord is passed and a knot tied so that it cannot escape: at the foot-board arrange a pulley on a level with the long axis of the leg; this pulley may be iron or wood, or even a large spool, and may be fastened on the foot-board of the bed, or in an iron or wood upright (Fig. 60); the weights may be obtained in sets and neatly adjusted to the rope, or they may be made to slide down one upon the other as the weights of the common scales. Now apply coaptating splints, which may consist of several narrow strips of thin board properly padded and of such length as to extend well above and below the fracture; or four sole-leather splints may be used which do not quite touch at their margins, the external and internal embracing the condyles; maintain these splints by four to six strips of bandage knotted over the front splint, or by straps with buckles. The amount of weight to be employed must be determined by the resistance to be overcome, and the toleration of the patient: the maximum is about twenty-two pounds, and generally not over twenty pounds can be long endured. Counter extension is made by the weight of the body, increased, if necessary, by raising the foot of the bed on blocks, or by

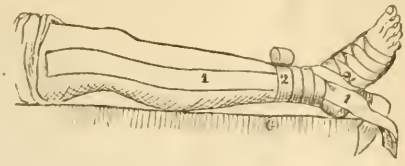


Fig. 59.[1]

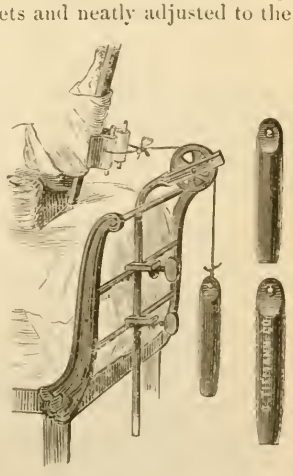


Fig. 60.

[1] A. Crosby.

a perineal band attached to the head of the bed (Fig. 61). Prevent eversion of the foot, especially in fractures of the neck, by long sand bags at the sides of the leg; or a long side splint, padded, may be used, having a transverse piece at the foot. Eight weeks is the usual time which a fracture of the thigh in an adult ought to remain in apparatus, but the extension may be lessened when the bones seem firm, and passive motion should be given to the knee-joint as early as the fifth or sixth week; the amount of shortening in adults, when overlapping continues, ranges from one fourth to one and a half inches.[2]

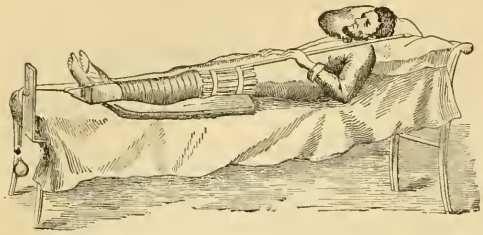


Fig. 61.[1]

The gypsum bandage should be employed only by those familiar with its use, and in a position to guard carefully against the dangers of too great compression.

It is applied as follows:[3] Place the patient with his nates overhanging one corner of a table, or with his body, shoulders, and head resting upon a mattress elevated by blankets about one foot from the table, but terminating about two feet from its lower end; press the perineum against an iron stanchion, firmly screwed upon the lower end of the table, and wound with heavy flannel cloth; suspend the nates by a sling passed under the small of the back and supported by a wooden bar projecting horizontally from the top of the stanchion to some

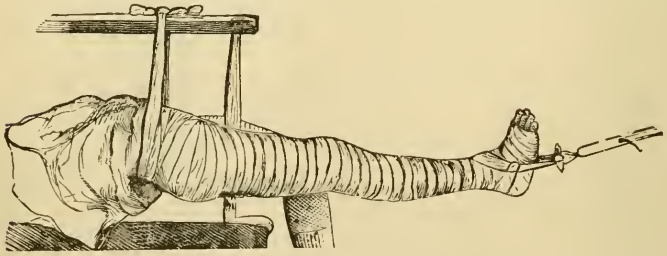


Fig. 62.

point of support of equal elevation beyond the head; attach compound pulleys to the foot, and give the anæsthetic; the patient being fully under the influence of the anæsthetic, make traction upon the pulleys until the shortening is overcome and the fracture reduced; the direction of the extension must be in the

[1] G. Buck. [2] Resolve of Am. Med. Assoc. [3] Bellevue Hospital Reports.

line of the axis of the body; envelop the limb with a dry bandage, cotton batting, or old blanket, cut to fit, or drawers, and protect especially the groin and gluteal fold from excoriation; apply the bandages, saturated with plaster, over the whole limb, from below upwards, including the pelvis; occasionally reinforce the successive turns of the roller by broad pieces of flannel or of patent lint, dipped in the fluid plaster; the number and thickness of the successive layers must be determined by the apparent necessities of the case, generally four or five layers of roller being required, at least upon the thigh; the dressing being completed, continue the extension fifteen or twenty minutes, until the plaster has become hard; on the second or third day after the reduction of the fracture, the patient is allowed to move about on crutches.

Fracture of the femur in children is best treated as follows:[1] Provide two long narrow side splints extending from near the axillæ below the feet; connect them by a cross piece at the lower ends so that they are a little more widely separated below than above, to render the perineum accessible; place them upon each side of the body; secure the leg of the broken limb to the splint with a roller, and fasten the remainder of the limb, the opposite limb, and the body to the splint with broad and separate strips of cloth; the coaptation splint may be made of binders' board; it is of great importance to confine both limbs, for as long as one is free it is almost impossible to secure any degree of quiet; the extended position is much to be preferred to the flexed.

9. **The patella** fractured transversely is effectually retained in position by the gypsum bandage (Fig. 63). Envelop the limb from the toes to the groin with sheet cotton or nicely fitting blanketing; apply the gypsum bandage from the toes to the groin, three thicknesses; when the dressing is hard, cut out a large fenestrum exposing the patella and adjacent parts; now apply strips of adhesive plaster over the lower fragment, the centre of each resting on the patella, and the ends extending upward and fastening to the splint; these strips should overlap each other one third from below upwards; when the lower fragment is firmly fixed, apply strips in a similar manner to the upper fragment, forcing it downward; it is well to apply a last plaster directly over the centre of the patella, to prevent the broken surfaces from tilting upwards.

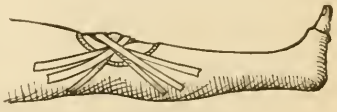


Fig. 63.

The following method[1] is often adopted: Elevate the limb upon a well-cushioned inclined plane, in which is cut a deep notch about four inches below the knee; the foot-piece is at right angles with the inclined plane, and not at right angles with the horizontal floor; and perforated with holes for the passage of tapes or bandages to secure the foot. Having covered the apparatus with a

[1] F. H. Hamilton.

soft and thick cushion carefully adapted to all the irregularities of the thigh and leg, take especial care to fill the space under the knee; lay the whole limb upon it, and secure the foot gently to the foot-board, between which and the foot place another cushion; the body of the patient should also be flexed upon the thigh, so as the more effectually to relax the quadriceps femoris muscle. Now place a compress made of folded cotton cloth, wide enough to cover the whole breadth of the knee, and long enough to extend from a point four inches above the patella to the tuberosity of the tibia, and one quarter of an inch thick, on the front of and above the knee. While an assistant presses down the upper fragment of the patella, secure it in place with bands of adhesive plaster; each band should be two or two and a half inches wide, and sufficiently long to enclose the limb and splint obliquely; lay the centre of the first band upon the compress, partly above and partly upon the upper fragment, and bring its extremities down so as to pass through the two notches on the side of the splint, and close upon each other underneath; let the second band, imbricating the first, descend a little lower upon the patella, and secure it below in the same manner; the third, and so on successively until the whole is covered, after which apply a roller from the foot to the groin.

The leg should not be flexed freely, under three months.[1]

10. **The tibia** is very little displaced, when broken alone, and requires only a leather splint,[2] or a properly adjusted plastic dressing. A very neat and simple plastic dressing may be made with flannel, plaster of Paris, and shellac,[3] prepared and applied as follows: After replacing the fragments as accurately as possible, extension being maintained by assistants, bandage the limb smoothly with cotton wadding, prepared in the form of an ordinary roller; now soak a flannel bandage spread with dry plaster of Paris and rolled, in warm water, adding about two fluid-ounces of saturated solution of sulphate of potassium, and apply to the limb, over the wadding, by circular and reversed turns; one layer of the flannel applied in this way is amply sufficient for support; the splints should be varnished with shellac. To inspect the point of fracture, the dressing, which is only about an eighth of an inch thick, is easily cut through.

To avoid the difficulty in removing plaster of Paris dressings when applied by the roller bandage to the leg, the following method of dressing is very convenient:[3] Take a woolen or cotton stocking sufficiently long to reach to the knee-joint, and cut from it as a pattern six layers of coarse red flannel, one quarter of an inch larger, to allow for shrinkage; soak the flannel in water, press and lay over the back of a chair, ready for use; sew a one quarter inch cotton rope to the posterior median line of the stocking (Fig. 64);

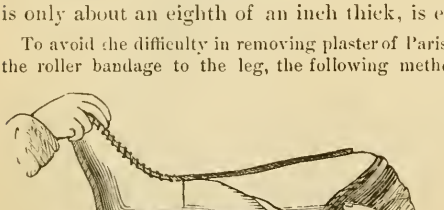


FIG. 64.

[1] T. Bryant. [2] F. H. HAMILTON. [3] G. WACKERHAGEN.

the plaster of Paris being in process of preparation; cut the stocking in the anterior median line, apply it to the fractured limb, lace up in front, including the rope, extension and counter-extension being kept up by assistants; adjust the fracture; saturate each layer of the flannel now separately in the plaster paste, and apply three layers to each side of the limb, being careful to avoid covering the rope; after this is done, apply a layer of plaster paste to the flannel, and, when this has become sufficiently dry, a coating of shellac varnish, which produces an elegant finish, and also gives firmness to the splints; the varnish will dry in about fifteen minutes. Remove by loosening the rope from the plaster and cutting the thread which binds it to the stocking; cut the plain stocking surface with an ordinary pair of scissors.

11. **The fibula** is most frequently fractured two or three inches above the lower end; the most convenient dressing is the gypsum, which must include the foot, except the toes; the fracture must be reduced and the foot held firmly in position until the limb is dressed and the material has hardened.

A useful dressing, frequently applied, is constructed as follows (Fig. 65):[1] Select a board, about four inches wide, of sufficient length to extend from the condyle of the femur to two or three inches beyond the foot; upon this place a long triangular pad, the thickest portion of the triangle corresponding to a point about an inch above the internal malleolus; the splint, with the pad resting upon it, lying along the inside of the leg, is secured by roller bandage, which must not cover the site of the fracture.

Fig. 65.

12. **The tibia and fibula** are usually fractured in the lower third. Apply a gypsum dressing[2] made as follows: Select two pieces of flannel, suited to the length and circumference of the limb, and cut them so as to overlap slightly in front, when they resemble the leg of a stocking opened vertically; lay one over the other, and stitch them together from top to bottom down the middle line, like two pieces of note paper stitched at the fold; spread them out under the limb so that the line of stitching corresponds to the back of the calf; bring the two inner folds together, over the shin (Fig. 66), and fasten them by long pins or by stitches; while the leg is held firmly in position, mix the plaster with about an equal bulk of water, and rapidly apply it, partly with a spoon and partly by pouring it over the outer surface of flannel covering the limb; quickly bring the two por-

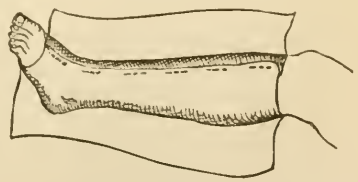


Fig. 66.

[1] Dupuytren. [2] Bavarian.

tions of the second layer over so as to meet, and smooth them with the hand, so as to remove the inequalities in the distribution of the plaster before it hardens; the gypsum sets in about three minutes, incasing the limb in a strong, rigid covering. To take the dressing off, open it like the leaves of a book; its edges must be trimmed, and the pins removed; maintain it in position afterwards by straps with buckles or a very firm bandage. This fracture may also be treated by leather splints, one on either side, extending from above the knee to near the tarso-phalangeal articulations. The apparatus must more or less completely envelop the limb. Sole leather cut so as nearly to inclose the limb, then softened in warm water and moulded to the leg, makes a firm dressing when it becomes dry.

A very simple gypsum splint may be made and applied as follows:[1] Select a piece of house-flannel or an old, thin, shrunk blanket, or any suitable substitute; shape the pieces by measurement, taking the circumference of the limb below the knee, at the biggest part of the calf, just above the ankle-joint, from the front of the ankle-joint round the heel to the front again, and at the middle of the metatarsus; the flannel of each splint should be in width half an inch less than half the circumference at any of those points; the width of the two splints should be one inch less than the circumference of the limb at any corresponding part, and long enough to extend from the tubercle of the tibia to the middle of the metatarsus; four pieces are required, two for each splint; prepare two bandages of common muslin, each five to six yards long and two inches and a half in width; mix about a handful of good dry plaster with water to the consistence of thick cream; lay the inside pieces of flannel on the table or bed, the outer surface being upwards; soak the outside pieces in the plaster separately, and lay them out on their respective inside pieces. Whilst traction is kept up, and the ends of the broken bones are maintained in apposition, the splints are to be applied and smoothed; then the bandage is to be put on; traction is to be maintained during the hardening of the plaster; next the limb should be laid on a large soft pillow, the toes directed upwards, and the knee a little bent; in the application of the bandage great caution should be observed that it is not drawn tightly anywhere, and that no one turn of the bandage is tighter than another; the two splints should not meet by about half an inch either down the front or back; the intervals are spanned by the dry, porous muslin; at the sides the bandage is fixed to the splints by the plaster, which oozes into it from the outer layer of flannel; if it becomes necessary next day, or later, to ease the splints, or to inspect the limb at any spot, the bandage can be slit up with scissors along the middle line in front. They are hinged together at the back by the muslin bandage which spans the interval there. These splints are characterized by their simplicity, stability, and economy, and therefore commend themselves strongly to the country practitioner; the surgeon can take out with him, to his case, a bag of plaster of Paris, and the muslin bandages, and perhaps the flannel; the plaster should be good, but need not be the very best; must be dry, and should be kept, when in store, in a dry, warm place; be cautious in using any flannel which has not been in some way shrunk.

[1] J. Croft.

II. COMPOUND FRACTURES.

A fracture is compound when it communicates through a wound with the external air. These injuries have always been regarded as dangerous because such wounds commonly inflame and suppurate,[1] but when they are protected from the action of septic ferments recovery will occur with slight inflammation and suppuration. The first question to determine is as to the possibility of saving the limb, and as a rule, the attempt should be made if the injury to the soft parts is not very great; if the bone does not largely protrude, and the skin is not extensively lacerated; if the continued warmth of the limb below the fracture indicate the escape of the main artery, and that the nerves are not implicated.[2] The thorough use of disinfectants, by which putrefactive suppuration is now prevented, adds largely to our means of saving limbs after compound fractures.

The first indication is to convert the compound into a simple fracture when the opening is very slight and readily closed; this may be done with collodion, or with any dressing which hermetically seals the wound. If the bone protrude, attempt reduction by extension and counter-extension; if this fail, introduce the finger or the spatula into the wound and endeavor to stretch the skin over the sharp point of bone; if all efforts fail, enlarge the wound sufficiently to insure return; if the bone is denuded or very sharp, saw off the projecting end; ligate ruptured arteries which can be readily found. Anæsthetics may be useful during these efforts.[3] If the case is seen at once, cleanse the wound, disinfect every portion liable to contain septic ferments, secure perfect rest, and prevent the entrance of any poisons. Employ the antiseptic dressing, which best meets these indications,[4] as follows: Use the spray during the dressing; if the contusion is slight, inject carbolic solution, 1 to 20, into the wound, and apply the gauze; if there is much contusion, enlarge the wound and inject the same solution freely and forcibly among the injured tissues, and dress as before; repeat the injection at every dressing when the discharge is offensive, opening the wound more freely, if necessary, to reach deeper recesses. If the suppuration has extended very deeply, and is offensive, the wound must be still more freely enlarged, and a solution of carbolic acid in wine, 1 to 5, injected, and if necessary through a tube introduced to the most remote recess.[4] If the gauze is not at hand at each dressing, after thoroughly disinfecting all parts of the wound with the carbolic solution, fill the cavities and the entire open spaces with pledgets of lint saturated with carbolized oil.

The plastic dressing should next be applied; if there is danger of

[1] J. Hunter. [2] F. C. Skey. [3] F. H. Hamilton. [4] J. Lister.

too much swelling, it may be applied only to the under and lateral surfaces, leaving the upper and injured surface free (Fig. 67). As early as possible, however, the gypsum dressing should be so applied as to completely envelop the limb, a protective being placed next to the skin, as cotton batting, or thick flannel; when completed and nearly dry, a fenestrum, or if necessary two or three, should be cut out so as to give full access to the wound (Fig. 68); the limb is then suspended.

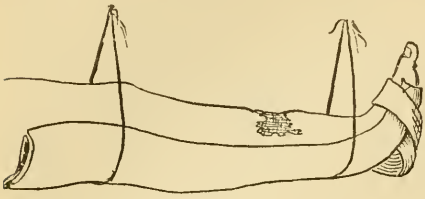


FIG. 67.

III. SHOT FRACTURES.

Projectiles[1] cause a variety of partial and complete fractures; the former are (1) removal of a portion of bone, (2) splintering off of fragments of the external cylindrical part of a bone, (3) making a hole throughout the entire substance of the bone, (4) driving the external cylinder into the cancellated structure; the latter are (1) simple when the injury is indirect, and (2) compound when the projectile is brought in direct contact with the injured bone. These fractures are always serious injuries, as they frequently involve the question of resection and amputation, and are always liable to dangerous complications, as hæmorrhage, tetanus, septicæmia, and pyæmia. The course of treatment indicated varies with the bone fractured, and the nature and extent of the injury.

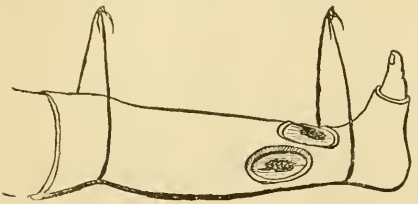


FIG. 68.

1. **The superior maxilla** has such relations to the structure of the face that every effort should be made to preserve its symmetry when broken by shot injuries. Unless the fragments are either completely detached or but slightly adherent, they should not be taken away, but be replaced with care, as in time consolidation may take place, and very little permanent deformity be left; after careful adjustment of the movable fragments, close the wound with adhesive plaster, and apply cold-water dressings; if fragments subse-

[1] T. Longmore.

quently loosen, remove them.[1] Bony union of these fragments usually takes place with great facility.[2]

2. **The inferior maxilla**, fractured by projectiles, is with difficulty retained in position; the fragments should be preserved and adjusted, and efforts made to retain them in apposition by the four-tailed bandage, with pasteboard cap for the jaw, and interdental splints of gutta-percha.[2]

3. **The clavicle** is in such relations with the pleural cavity and the larger vessels of the neck that serious complications frequently attend shot fractures of that bone. In the treatment of uncomplicated fractures, remove detached splinters immediately, and necrosed fragments at the earliest practicable moment;[3] then leave the injury to nature, with as little operative interference as possible, for the less the wound and bones are manipulated the better the result.[4]

4. **The humerus** should always be subjected to conservative treatment, unless extremely injured by a massive projectile, or longitudinal comminution exist to a great extent, or a joint is also involved, or, finally, the patient's health is unfavorable.[5] In cases which admit of conservative treatment, proceed as follows: If the bone is much splintered, extend the wound if necessary for exploration and operation, at the most depending opening if there are two wounds, or make a fresh incision if only one exists and it is not in a favorable position; make an examination with the finger for any foreign bodies or detached pieces of bone, and remove them; remove also such partially detached portions and fragments as are retained only by very slight and narrow periosteal connections, and saw or cut off sharp points of projecting spicula.[5] Dress the wound with lint soaked in carbolized oil, and support the limb by a fenestrated splint of gypsum, or sole leather, or other material capable of being moulded to it, and which will secure rest. Immobility is securely obtained by a triangular cushion[6] and axillary pad interposed between the thorax and the arm (Fig. 69).

This useful appliance consists of a three-cornered cushion, with rounded edges, made of horse-hair, upholstered with soft material, and inclosed with waterproof material. It is applied as follows: One of the rounded edges is placed in the axilla, and is then fixed by a bandage, attached behind and in front by safety-needles, and passed over the opposite or healthy shoulder; the fractured arm is then laid upon the cushion, and both are maintained in position by a broad sling; the wound is now dressed with a Scultetus' bandage, the edges of the sling being drawn back for that purpose.

5. **The radius and ulna**, like the humerus, should be conservatively treated unless there is partial ablation by a cannon ball, or comminution of both bones with laceration of the blood-vessels and

[1] J. J. Chisholm. [2] F. H. Hamilton. [3] G. A. Otis. [4] B. Beek.
[5] T. Longmore. [6] F. Stromeyer.

nerves, or extensive comminution in the vicinity of joints, with fissures extending into the articulations.[1] After extracting loose frag-

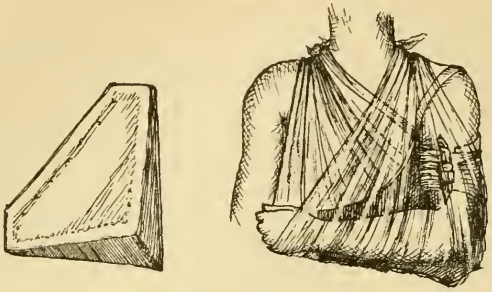


Fig. 69.[2]

ments, if no considerable deformity exists, only simple splints and bandages are required; if there is great tendency to displacement, the fenestrated gypsum dressing, applied when the arm is midway between pronation and supination, with a slightly bent elbow, is most useful.[3] If but a single bone is fractured, the most simple splint dressing is required.

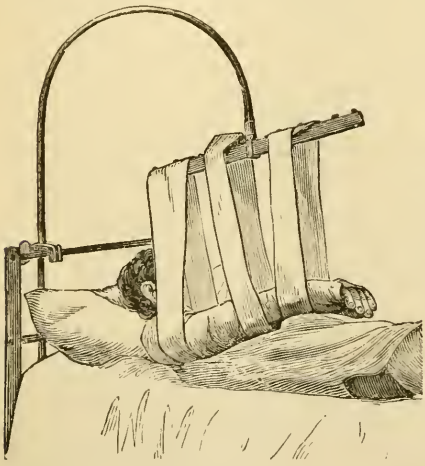


Fig. 70.

Suspension of the fore-arm in the early stages of treatment is very important, and may be effected by simple apparatus, as follows (Fig. 70):[4] Select iron tubing, or other material, fasten its upright portion by clamps at the head of the bedstead, while its lower portion overhangs the bed and holds suspended at its extremity a flattened strip of hard wood, on the upper edge of which a row of screw heads serves for fastening the ends of the canvas bands that suspend the limb; the strip of wood that supports the limb should play horizontally on a swivel joint at the extremity of the iron tubing.

6. **The metacarpal and phalangeal bones** should, as far as practicable, be preserved, whatever the nature of the injury, though their functions may subsequently be greatly limited. Their wounds

[1] F. Schwartz. [2] F. Esmarch. [3] H. Fischer. [4] G. Buck.

are extremely painful and troublesome in management, but are not specially liable to induce tetanus.[1] In the treatment, splinters and foreign bodies should first be removed; free incisions[1] through the aponeurotic layers are important in preventing accumulations of matter under fasciæ and tendons, or relieving tension caused by such collections. Carbolized oil dressings pressed into the wounds in ordinary cases, and the hot water in those liable to extensive sloughs, should be early resorted to and persistently used; the hand may be supported upon properly adapted splints.

7. **The femur,**[2] fractured by a modern rifle-ball, is generally extensively comminuted, and often fissured for long distances along the shaft; an attempt to conserve the injured limb, however free from complications, and however favorable the case may appear to be, will unavoidably subject the patient to a wide variety of hazardous circumstances, owing to the prolonged treatment and attendant difficulties which must necessarily occur before a cure can be completed. If the femoral artery and vein have been divided, any attempt to save the limb will certainly prove fatal. In shot fractures of the upper third of the femur, especially if it be doubtful whether the hip-joint is implicated or not, the question is still open whether excision of the injured portion, or removal of the detached fragments and relying on the natural efforts for union, or amputation, which is very dangerous, is best for the safety of the patient. The decision must depend upon the extent of the injury to the surrounding structures, the condition of the patient, and other circumstances in each individual case. As a general rule, in fractures in the middle and lower third of the thigh, amputation is held to be a necessary measure. When it is determined to attempt to save the limb, the wound may be enlarged to remove spicula of bone, and occasionally counter openings should be made to prevent the accumulations and burrowing of pus; carbolic solutions should be injected into all the recesses, and carbolized oil on lint be introduced with forceps to avoid creating additional irritation; cold water or ice dressings may at first be applied, to be discontinued if suppuration occurs. The part should finally be perfectly immobilized by apparatus; for this purpose the splint should allow the limb to be swung so as to admit of dressing without change of

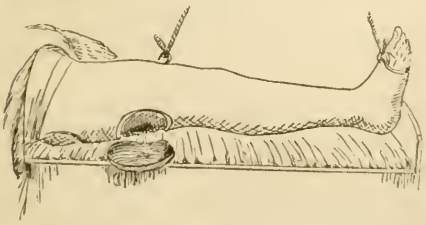


FIG. 71.

[1] G. A. Otis. [2] T. Longmore.

position. The gypsum splints or the fenestrated gypsum bandage may be employed (Fig. 71), or the cradle with a light weight at the foot (Fig. 73). A wire suspending apparatus[1] (Fig. 72) has given good results: —

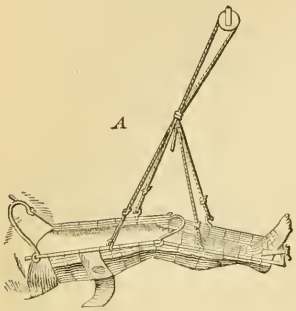


Fig. 72.

The frame is stout wire; strips of cloth are laid across the splint from side to side, and upon these the limb is laid; the centre and upper extremity of the splint are kept asunder by strong bows of iron wire, so arranged that they can be put on or taken off without disturbing the dressings; when applied, the inside wire must be bent upwards at its upper extremity, so as to make room for the pubes; extension is made by adhesive plasters, and the whole apparatus is finally suspended to the ceiling or to some point above by a rope or pulley.

8. **The tibia and fibula**, fractured without implication of the knee or ankle joints, are very amenable to conservative measures, and hence, as a general rule, ordinary fractures below the knee, from rifle balls, should never cause primary amputation.[2] The treatment should consist in freeing the wound of all foreign matters and splinters, the local use of carbolized oil on lint, and the application of the gypsum splint noticed in the treatment of ordinary compound fractures in this region.

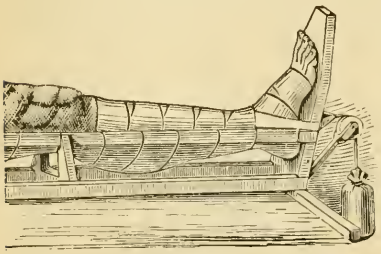


Fig. 73.[3]

A very simple apparatus[1] may be made, consisting of a wooden frame formed of four square bars of the length of the lower extremity, two on either side of the leg, united by a crescent-shaped piece of wood situated at the back of the knee, and by a foot-board below; the lower two serve the purpose of holding the apparatus together, and making an inclined plane; the upper bars serve as points of attachment for a number of linen straps or rollers to suspend the limb, which pass from side to side and are fastened with pins; they constitute a perfect bed, having the advantage of adapting themselves to the differences in the conformation of the limb; the foot is retained to the foot-board by long adhesive plaster strips, passed around the foot-board and carried upwards and secured to both sides of the leg with roller bandage, leaving a sort of loop beneath the foot-board, through which a rope is passed and attached to a little bag weighted with sand, for the purpose of keeping up extension; counter-extension is made by a perineal band, the end of which is secured to the head of the bed; a long cross-bar under the foot-board, resting on the bed, prevents the apparatus from

[1] J. T. Hodgen. [2] T. Longmore. [3] G. Tiemann & Co.

tilting; bricks may be placed under the legs of the bed at the foot, to give the apparatus an inclination towards the pelvis; one of the advantages of this instrument is that each of the bands of linen may be removed separately, any wound dressed, and the band reapplied without displacing the others.

CHAPTER XIII.

DISEASES OF BONE AND SPECIAL OPERATIONS.

Morbid anatomy illustrates physiological processes very markedly in the osseous system; in every case some analogy at least may be discovered between the morbid phenomena and a normal prototype; in many cases there is a simple excess or deficiency of normal growth, but in the larger number there is a predominant activity of single anatomical factors whose part in normal growth is more subordinate.[1] In the examination as to the condition of bone, much useful information may be obtained in obscure cases, both as to the seat and nature of the disease, by percussion;[2] the instrument used should be a metallic hammer with a whalebone handle, and the bone should be firmly compressed on two sides; of the more noticeable sounds elicited by percussion of diseased bone are a high pitch when the bone is very compact, as in osteo-sclerosis, and a hollow sound when the bone is very porous, as in osteo-porosis.

I. RICKETS.

The swellings and distortions of rickets depend on a morbid acceleration of those changes which usher in and prepare the way for the transformation of cartilage into bone, and the development of bone from periosteum; ossification follows at a slower pace, and hence the substance which should undergo immediate conversion into bone-tissue accumulates, forms swellings, and allows the bones to be bent and broken.[1]

In its various forms rickets[3] is a very common affection in children from six months to two years of age, who live in damp, dark, ill-ventilated apartments and have insufficient or improper food. Faulty digestion results in the development of acids, mainly lactic, in the blood, and the rapid elimination of the phosphates by the kidneys. The child grows feeble, peevish, melancholy, has perspiration of the head; the ends of the long bones, radius, tibia, and ribs, enlarge, and those bones subjected to pressure bend.

The general treatment is (1) fresh air and sunlight; (2) cod-liver oil, and syrup of iodide of iron, or the compound syrup of the phosphates. The mechanical treatment consists in supporting the bones

[1] E. Rindfleisch. [2] A. Lücke. [3] J. L. Smith.

which are inclined to curve during the period of softening; the greatest care and discretion are required to avoid doing harm by undue pressure on yielding bones; as far as possible the weight of the body should be taken from the long bones, and when curvature occurs gentle lateral support should be given by well-padded splints, making such points of pressure as will not involve other bones. Plastic apparatus may be applied to support a weak spinal column and the lower extremities. The curvature of the lower limbs may be very firmly supported by apparatus which protects the bones without other pressure. If curvature exists, much may be accomplished in straightening the limb of the child that does not walk, by firm pressure and extension with the hands, repeated several times daily. When the child is walking an apparatus may be adjusted to the tibia. (Fig. 74.)

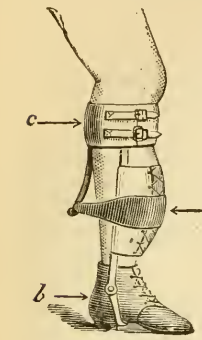


FIG. 74.

Two upright steel stems are fastened below to a shoe and terminated above in the calf-band; a leather bandage is passed around the stems and tightly laced in front over the arc of the curvature (*a*), or a strap is passed over the arc of the curvature and fastened to a spur suspended from the calf-band behind (*c*); the points of resistance being in either case the heel of the shoe (*b*) and the posterior trough of the calf-band (*c*).

When the bones of the leg and thigh are both bent, the apparatus must be so constructed as to overcome the deformity which takes different directions.

The support is given by double stems of steel, secured to a shoe, carried up as high as the thigh and jointed at the ankle and knee to allow the patient perfect freedom of motion; they are kept in place by calf and thigh bands. The bow is corrected by pads being placed respectively against the ankle and knee on the concave side of the limb, whilst a strap passed around on the highest point of the arc, inside of the outer stem, tightly buttoned to the steel bar on the concave side, gradually compels the leg to become parallel with it; in slight cases, or when the bow is greatest below the calf, an instrument carried up to the knee is sufficient.

When the bones have become consolidated in deformed positions which impair function, they must be straightened by osteoclasis or osteotomy.

II. TUMORS OF BONE.

Osseous tumors are distinguished from other ossifying tumors by the uniform production of true bone as an essential element in their development.[1] They are never formed altogether of bone, but there is always present an ossifying matrix, derived generally from the perios-

[1] R. Virchow.

teum and cartilage; the amount of periosteum, cartilage, and bone present varies indefinitely in different cases.[1] In the diagnosis,[2] general smoothness of surface is usually significant of a tumor growing within a bone and expanding it, unless in the case of cartilaginous tumors, which, after growing within bones, have protruded through some of their expanded walls; pulsation in a non-cancerous tumor connected with bone is a nearly certain sign of growth within bone, except in the case of myeloid epulis; if these means of diagnosis are insufficient, resort to puncture or an exploratory incision. In operations for the removal of tumors of bone, the following general rules[2] should be borne in mind: (1) Simply removing a tumor from the place in which it lies is as sufficient for the cure of one growing in a bone as for that of one growing in connective tissue; (2) it is rarely necessary to disturb the continuity of a bone in order to remove from it any innocent tumor; (3) the safety of removing a tumor from within a bone is greater than that of any resection or amputation that might have been performed as an alternative operation; (4) innocent tumors growing on bones should be removed by excision, and growing in bones by enucleation; (5) cancerous and recurrent tumors should generally be removed by amputation or wide excision.

1. **Chondromata**, cartilage tumors, are usually seated in the bones; the phalanges of the fingers and toes are more often affected; next, the humerus, femur, and tibia; next, the jaws, pelvic bones, and scapula; they may spring from the periosteum and from the medulla; new bone may form, layer after layer, producing a bony capsule which may continue for a long time.[3] They are of slow growth, painless, rounded, nodular, and when very large prone to ulcerate. The treatment is removal when life is not endangered by the operation. Enucleation[2] is a method to be preferred when it can be effected, as in the bones of the hand, the elastic bandage being first applied to the limb; amputation is necessary when the growths are multiple or very large, or when the limb would be useless after their removal;[4] if the tumor is in the femur, disarticulation is advisable.[5]

2. **Exostoses** are manifestations of an increased physiological activity of the periosteum; in the majority of cases some general disease, as syphilis, rheumatism, or rickets, has a part in their causation, though an injury is often the assigned cause.[3] They frequently occur in the multiple or diffuse form. They may consist of (1) spongy bone-substance, which occurs almost exclusively on the epiphyses of the long bones, outgrowths from the epiphyseal

[1] R. Moxon. [2] Sir J. Paget. [3] E. Rindfleisch. [4] T. Holmes. [5] T. Billroth.

cartilages, but from the first being intimately connected with the spongy substance of the epiphyses; (2) compact bony substance, ivory-like, which develops on the bones of the face, skull, pelvis, scapula, great toe; (3) ossification of tendons, fascia, and muscles, where they are attached to bone. These tumors form without pain, and are inconvenient when in the vicinity of joints or on the toe, and unsightly when on the face or head. The only treatment is excision, which is neither advisable nor necessary, unless the impairment of function be so great as to balance an operation dangerous to the joint and to life, for these tumors in time cease to grow. On epiphyseal exostoses mucous bursæ are often found, usually communicating with the joint, which are liable to be opened and lead to unfortunate results.[1] These growths do not return when removed.[2] When they appear on the great toe the phalanx should be amputated. The ivory exostoses of the skull owing to their hardness are generally excised with extreme difficulty by means of saw and chisel, and the violence involves very great danger. As they may exist without other inconvenience than the deformity which they cause, the risk of excision should not be lightly incurred. An exception must be made in the case of ivory exostoses of the orbit, as the gradual growth of such tumors displaces the eye, causing blindness, by stretching the optic nerve, and a hideous squint; the base, usually attached to the inner or outer angle of the root of the orbit, is often small, and when fully exposed can be partially cut with a fine saw, and then broken with the chisel and mallet.[3] Exostoses of the antrum often have very small bases and are removed without difficulty on opening the front wall of the cavity.

3. **Sarcomata** comprise two groups, namely, the external and the internal, the former springing from the periosteum and the latter from the medulla. The periosteal growths embrace for the most part the hard forms, namely, the fibro, chondro, and osteoid sarcomata; they take their origin from the layer of the periosteum next to the bone, while the external layer often remains as a fibrous investment which, by its unyielding character, retards the growth; the cortical portion of the bone is not at first involved, and if very thick, as in the diaphysis of long bones, it may become only superficially affected, but if the tumor appear where spongy bone is near the surface, as in the epiphyses of long bones, the growth spreads into the medullary spaces and it is difficult to distinguish periosteal from medullary sarcomata.[4] They are quite malignant[1] and usually contain all the varieties of sarcoma tissue, but the spindle cell-tissue predominates in most cases, especially in those enormous tumors which are developed on the ends of the great bones of the extremi-

[1] T. Billroth. [2] E. Rindfleisch. [3] T. Holmes. [4] R. Virchow.

ties.[1] The medullary form, myeloid tumor,[2] myelogenic osteo-sarcomata,[3] appear especially in the jaws, as epulis;[4] next in the tibia, radius, and ulna; these tumors often contain mucous cysts and spherical or branched osseous formations, circumscribed nodules mostly forming in the medullary cavity, which gradually destroy the bone; but new bone is constantly developed from the periosteum, so that the tumor, if very large, often remains covered, entirely or partially, by a shell of bone, which appears puffed up like a bladder; in the lower extremity they become very vascular; small traumatic aneurisms develop in them with the true aneurismal murmur; cysts also develop in them; they are usually solitary, rarely generally infectious; they appear in the jaws at the second dentition, and in the long bones at middle age.[5] When the growth is periosteal the fibrous tumor resembles it, but the sarcoma is softer, more elastic, and vascular; when within bone it is difficult to distinguish sarcoma from other innocent tumors; it differs from cancer chiefly in that it is of slower growth, has a broadly rounded shape, and its seat is in the articular end rather than in the shaft of a bone; in the absence of glandular disease and of all cachexia, though three or four years may have elapsed.[2] Excision is the only available remedy, and should be resorted to without delay, the base being thoroughly removed.[2]

4. **Fibromata**[5] springing from the periosteum are quite frequent, and are generally composed of fibres and spindle-shaped cells; the latter may preponderate, giving the growth the character of a fibro-sarcoma; the periosteum of the bones of the skull and face, especially the inferior turbinated bones, is particularly liable to this disease; in the latter position the tumors appear as naso-pharyngeal polypi; these tumors may form in the interior of bone, especially in the upper jaw; they are most common in the young, but after puberty. They are hard, round, of slow growth, and without pain. The treatment is removal by enucleation.

5. **Carcinomata** occurring in bone may originate by a propagation of the infiltration from cutaneous, mucous, or glandular cancers; but cancer apparently also appears originally in bone, though it may have an epithelial origin, as in case of those soft and quickly growing cancers which spring from the upper end of the humerus and femur, at one time from the medulla and at another from the periosteum.[1] It may assume various forms, namely, encephaloid, which is most common, scirrhus, and epithelial. The diagnosis[2] in obscure cases must be made in favor of cancer (1) when the tumor commences growth before puberty or after middle age, unless

[1] E. Rindfleisch. [2] Sir J. Paget. [3] R. Virchow. [4] E. Nélaton. [5] T. Billroth.

it is a cartilaginous or bony tumor on a finger or toe, or near an articulation; (2) when the tumor on or in a bone has doubled, or more than doubled, its size in six months, and is not inflamed; (3) if, in addition to rapid growth, the veins over the tumor have much enlarged, or the tumor has protruded far through ulcerated openings, bleeds, and discharges matters; (4) if, though the tumor is not inflamed, the neighboring lymph glands are also enlarged; (5) if the patient has lost weight and strength out of proportion to the damage to health by pain or fever or other accident of the tumor; (6) if situated on the shaft of any bone but a phalanx. The treatment of all forms of cancer of bone must be by amputation when the disease is local; the point selected must be as far as it may be safe to operate from the seat of the malignant growth.[1]

III. INFLAMMATION OF BONE.

The morbid changes included under the term inflammation of bone are remarkable for their clinical diversity and singular anatomical uniformity; there is no deviation from the physiological type, except where pus forms, which introduces infinite complications into the whole course of the inflammatory process, as repair can be brought about only by circuitous methods.[2]

1. **Periostitis**, acute, occurs chiefly in young persons, and in its typical forms almost exclusively in the long bones, as the femur and tibia; at first there is high fever, not unfrequently a chill, severe pain in the affected part; swelling without redness; skin tense and usually œdematous; every touch or jar is very painful. The inflammation may resolve at this stage, or progress to suppuration, when additional symptoms appear: the swelling now increases, the skin becomes reddish, then brownish red, the œdema extends, the neighboring joint becomes painful and swells, and towards the twelfth day fluctuation is detected.[3] The inflammation often occurs in the periosteum of the third phalanx, felon, causing great suffering, and terminating in necrosis. In the early stage of the disease in the long bones apply the strong tinct. iodine. and repeat when the vesicles dry up;[3] add ice, if, when applied until the deeper parts are cold, it is agreeable and the pain subsides. When effusion takes place and is confined beneath the dense fibrous periosteal layer, free incision down to the bone gives immense relief; as the object is to relieve tension, the incision should be made as soon as this condition clearly exists, though pus may not have formed; this practice is especially important when the upper part of the shaft or the articular end of a bone is affected.[4] The local applications should now be soothing, as fomentations, and carbolized solutions should be freely used in

[1] Sir J. Paget. [2] E. Rindfleisch. [3] T. Billroth. [4] T. Bryant.

the wound to arrest septic changes. Pus should be freely evacuated wherever it may be found, and free drainage secured by position or drains. The general treatment should consist of anodynes, with laxatives and low diet, to relieve pain and inflammation; and tonics and nutritious food when suppuration is established.

2. **Osteo-myelitis**, acute, is an inflammation of the medulla of bones; it occurs in the young and is generally caused by injury; the symptoms are, intense aching pain at the seat of inflammation which is relieved only by perforation of the bone; swelling, which begins as a puffiness but has a peculiarly abrupt margin and as the disease spreads advances up the limb; red and hepatized appearance of the marrow, seen in the bone of a stump; globules of oil mixed with the pus discharged; irritative fever with great restlessness, and in bad cases delirium.[1] The symptoms so closely resemble those of suppurative periostitis that in many cases it cannot be discovered whether only the periosteum is affected or the medulla also; but if while there is great pain and fever, or complete inability to move the limb on account of pain, swelling does not occur for several days, it is to be inferred that the seat of the inflammation is the medullary cavity.[2] The inflammation may induce acute periosteal abscess, thrombosis, pyæmia, necrosis, and the separation of the epiphysis by the suppuration of the epiphyseal cartilage. The indications of treatment are: removal to the open air; elevation of the part, but with depending opening for free discharge of pus; local applications of ice when agreeable to the patient; free use of disinfectants; application of the strong tincture of iodine; tonics, as quinine and iron. If antiphlogistic remedies fail and the pain increases to a violent degree, make free incision and trephine the bone to relieve the tension;[3] if the integrity of the bone is destroyed, resect, or amputate. Amputation in the continuity of the affected bone is injurious, but disarticulation of the bone at an early period, before pyæmia occurs, has given good results.[1]

It is maintained that extensive wounds are bad in feverish patients, and predispose to pyæmia, and that disarticulation is erroneous because, first, the diagnosis is not certain, second, the results obtained are uncertain, and, third, the prognosis in exarticulation of large limbs, for acute disease of the bone, is always doubtful.[2]

IV. CARIES OF BONE.

Periostitis and osteo-myelitis may terminate in circumscribed suppuration, which results in ulceration or caries of bone.

1. **Superficial caries** corresponds to an indolent ulcer of the skin; the surface of bone exhibits a loss of substance which gradu-

[1] J. A. Lidell. [2] T. Billroth. [3] L. Bauer.

ally increases in depth, but remains shallow, and continually throws off small quantities of pus and shreds of decaying structures, derived from the denuded medullary tissue, which at a certain depth is in a state of hyperæmic proliferation, passing near the surface into an exceedingly dense corpuscular infiltration; the cells occupy all the pores of the bone tissue and leave no room for blood or blood-vessels, which are finally converted, with the cells, into molecular débris.[1] The symptoms are tenderness, œdema, severe boring and tearing pains at night.[2] The process of cure consists in the detachment and removal of the necrosed portions or particles of bone, cessation of the process of proliferation, shrinking together of the interstitial granulation tissue, and its transformation into cicatricial tissue.[2] The indications as to general treatment are the improvement of the health by tonics and hygienic measures; the local treatment is: (1) Removal of the purulent débris; (2) arrest of the carious process; (3) healing of the surface. If the caries affects the shaft of a long bone, easily accessible, as the tibia, expose the carious bone by a free incision, whether the pus is still contained in an abscess or is escaping from a sinus; cleanse the exposed surface of all foreign matters; very gently remove, with forceps or periosteal knife or gouge, every particle of dead bone, without injury to the living bone; apply the strong solution of carbolic acid, 1 in 20, to the surface of bone; complete the dressing by packing the wound with carbolized oil, 1 in 10; place the part in a condition of perfect rest, using plastic apparatus if necessary; renew these dressings only when required for cleanliness, and change the application to bals. Peru when granulations cover the bone.

2. **Central caries** usually begins in a hollow bone as an osteomyelitis; the inflammation extends to the inner surface of the cortical substance, which is dissolved, and pus may form quite early in the centre of the new formation, creating what is known as a bone abscess; the periosteum is thickened, new bony deposits form from the surface of the bone, and the hollow bone is thus enlarged externally at the point where the abscess forms, giving it the appearance of inflation; the central caries may be accompanied by partial necrosis of portions of bone on the internal surface of the cortical substance.[2] These bone abscesses more often form in the spongy portion of long bones, especially of the tibia. The symptoms are very often uncertain, as the chronic inflammation may exist deep in the bone; there may be only a dull pain, with but slight impairment of function; it is only when there is severe pain on pressure and œdema of the skin, showing that the periosteum is involved, that the case becomes more apparent; but it may happen that the true state of the disease can

[1] E. Rindfleisch. [2] T. Billroth.

be determined only when perforation has taken place and the probe may be passed into the cavity.[1] The most reliable symptoms, when present, are severe, long continued, and paroxysmal pain and local swelling, often at a single point, where there is extreme tenderness on pressure.[2] The treatment is trephining; mark on the skin the precise spot where the tenderness and pain are located; give an anæsthetic and make a crucial incision down to the bone, raise the periosteum to the requisite extent, and with the trephine open the cavity.[2] If no pus is found, puncture the surrounding bone with a strong awl or drill, for the pus has been found just beside the track of the trephine.[3] The abscess cavity should be cleansed and filled with pledgets of lint saturated with bals. Peru.

A less severe operation is at times of equal value, namely, puncture with a drill, especially when the seat of the abscess is not well defined.[4]

3. **Internal and external caries** may be accompanied by necrosis and by suppuration or osteo-plastic periostitis in the same hollow bone; abscesses appear at different points; rotten bone and a sequestrum may, at the same time, be felt with a probe; at one point the surface is exposed, and at another the interior; the whole bone is thickened, as is the periosteum; thin pus escapes from the fistulous openings; the surface is thickly covered with porous osteophytes; necrosed portions lie here and there; the medullary cavity is partly filled with porous bony substance, and round holes are found containing necrosed bone.[1] The proper treatment of a bone in this condition is usually extirpation or amputation, as recovery cannot be expected by any method of treatment.[1]

V. NECROSIS OF BONE.

The complete arrest of nutrition in a certain portion of bone, which results in its death, is usually due to suppurative periostitis as a proximate cause, even in traumatic cases, though not an invariable consequence; the pus excites a sequestrating inflammation both in the periosteum and the bone; the former being converted into a pyogenic membrane, is separated from the bone, while a fungating ostitis, fed by the medulla, is set up in the bone, which shuts off the organism by granulation tissue; the dead bone is called the sequestrum, and the fungating ostitis which separates it, demarcation; the detached periosteum develops a layer of new bone immediately under the pyogenic surface, forming a capsule, the involucrum, which incloses the sequestra.[5]

1. **Partial necrosis** of the diaphysis occurs when the outermost

[1] T. Billroth. [2] C. Jackson. [3] T. Holmes. [4] T. Bryant.
[5] E. Rindfleisch.

layers of the compact substance of bone have been too long cut off from the circulation and nutrition to allow their vitality being restored from the medulla; the fungating ostitis does the work of a sequestrating inflammation, detaching the lamellæ of dead bone and mingling them with the pus which fills the abscess cavity.[1] The presence of dead tissue is recognized when it is exposed by its white appearance, with dark places if it is situated deeply. Only the probe introduced through sinuses can exactly determine its presence; in addition, there is increased thickness due to the new formation of bone. The treatment at first should be limited to keeping the fistulæ clean; chemical solution of the sequestrum is liable to affect injuriously the new-formed bone, and thus do harm; mechanical removal of the dead bone is the only proper method; but it is important not to attempt removal until the dead is completely separated from the living bone, for the dead bone can rarely be detached without removing a good deal of the healthy and of the newly-formed bone; nor is the involucrum firm enough before complete detachment.[2] The complete separation of a superficial sequestrum is generally easily made out with a probe.

2. **Total necrosis** of the diaphysis results from suppuration of the periosteum and medulla; the pus from the periosteum perforates the soft tissues and escapes, but that from the medulla falls to detritus or putrefies within the bone; the process of detachment is effected by an interstitial proliferation of granulations in the edges of the living bone by which a slight amount of bone is consumed; the sequestrum now lies loose in a pus cavity; this detachment of thick hollow bones requires months and sometimes more than a year; meantime the periosteum has formed a shell of new bone which in time becomes very thick, and finally compact.[2] The probe is the guide to determine whether the bone is loose, but, it is difficult to decide on the mobility of a large sequestrum, especially when the bone is curved, as the lower jaw; the duration of the process and the thickness of the bony case are important aids; most sequestra are usually detached in eight or ten months, and in a year, even an entire diaphysis usually becomes detached, completely separated from its connections.[2] The treatment is, in general, the same as in partial necrosis; but this distinction must be made, namely, if the formation of bone be still weak, though the sequestrum be already detached, it is well to postpone the extraction in case of the humerus, tibia, and femur, so that the formation of bone may be firmer;[2] it may be necessary occasionally to resect when no new bone exists.[3]

[1] E. Rindfleisch. [2] T. Billroth. [3] T. Holmes.

CHAPTER XIV.

GENERAL OPERATIONS ON THE BONES.

I. SEQUESTROTOMY.

THE removal of necrosed bone may be effected by successive slight operations by which the periosteum is gradually separated from the dead mass, the indirect method, or by a single formal operation, the direct method.

1. **The indirect method**[1] is to be preferred when the bone is superficial and it is desirable to preserve its contour,[2] as in the removal of large sections of the tibia, the lower and upper jaw, the clavicle. This method consists in separating from time to time the diseased periosteum from the bone beneath with the handle of the scalpel or with a small spatula, the periosteum not being raised beyond the limits of the disease. By this means free escape for pus is constantly maintained, the new-formed bone becomes more perfectly adapted to the space occupied by the old, and the tissue of the new structure is more firm. When at length the sequestrum is separated it is readily raised from its bed with scarcely the appearance of blood, and the shape and function of the bone is largely preserved.

2. **The direct method** is often tedious, and much complicated by the oozing of blood into the wound; to avoid bleeding, the vessels of the limb should, as far as practicable, be emptied of their blood; as the elastic bandage, so effectual in removing blood from the limb, would be liable to force infectious matters into the meshes of the cellular tissues, and the extremities of lymphatic vessels, it is better to empty the limb as completely as possible by causing it to be raised high in the air for a few moments, and then apply the elastic bandage or tubing above the point of operation.[3] The operation is as follows:[4] If the opening in the bony case is large, and the sequestrum small, attempt the direct removal with strong forceps through this opening; if this is impracticable, with a stout knife make an incision through the soft parts down to the bony case from one fistulous opening to another; with a periosteotome draw the thickened soft parts from the rough surface of the bony case to just sufficient extent; remove this exposed portion with a saw, or a chisel and hammer, or gnawing forceps; the sequestrum being exposed, attempt its removal by elevators or strong forceps; first move it gently in its case in different directions until free from all spiculæ;

[1] J. R. WOOD. [2] Von Langenbeck. [3] F. ESMARCH. [4] T. Billroth.

if the sequestrum is not detached, avoid forcing it out, but wait a few weeks or months until its separation is complete. After the operation the suppurating cavity is to be kept clean, and the parts maintained in a state of rest; the ossifying granulations fill the cavity slowly, and the fistulæ may remain open for a long period, but the process of closure cannot be hastened unless the walls become sclerosed and cease to granulate, when the application of the hot iron to the cavity, or the chisel to the fistulæ, may be beneficial.

II. RESECTION.

Extirpation of bone in part or whole is frequently required, as after injuries which have destroyed their vitality, or after diseases which have resulted in necrosis, or in the removal of tumors. But such an operation is justifiable only when it is evident that resection is preferable to every other remedial measure.[1] When the operation is undertaken it must be so planned and executed as to become the first step in a process of repair by which a part is restored to more or less complete usefulness that would otherwise have been sacrificed.[2]

1. **The indications** for resection must be determined by the condition of the patient and of the diseased part. In general the operation is indicated only when the general health admits; for if the patient is suffering from a progressively wasting disease, as tuberculosis or marasmus, which will necessarily prove fatal, resection would be unwise, as repair would not follow.[3] In injuries, as gunshot, only such fragments of bone should be removed as are nearly or quite detached from the periosteum. In caries of hollow bone the ulcer may be thoroughly cleaned out with the gouge and the cavity be allowed to close by granulation,[4] but if the bone is small, extirpation may be necessary to arrest the process at once.[3] If a hollow bone is affected throughout, as with periostitis, external and internal caries, partial internal and external necrosis, extirpation of the entire bone may be required, as the only alternative of amputation.[3] Tumors of bone,[5] if not malignant, must be removed from their locality, but if malignant, extirpation of the bone or wide resection is necessary.

2. **The time** of operating after an injury, as a gunshot, should, if possible, be within twenty-four hours of the accident, or primary; if it is delayed beyond this period it should not be performed until the intermediary stage of inflammation is passed.[6] If the bone is necrosed the invariable rule should be not to attempt removal before complete detachment, because the dead bone can rarely be

[1] F. C. Skey. [2] A. Wagner. [3] T. Billroth. [4] C. Sédillot. [5] Sir J. Paget. [6] G. A. Otis.

sawed out without removing healthy and newly-formed bone; and the new bone is not firm enough before the sequestrum is detached.[1]

Fig. 75.

Fig. 76.

3. **The instruments** required in resection may be few or many, both in number and variety, according to the nature of the case. (1.) The knife (Figs. 75 and 76) should be broad and firmly set in a

Fig. 77.[2]

Fig. 78.[3]

Fig. 79.[4]

rough handle, which may or may not terminate in a periosteotome. (2.) The retractor may consist of broad metal plates properly curved (Figs. 77, 78), or take the form of hooks (Fig. 79); the latter are less liable to slip out of the wound, but do not so effectually open it.

Fig. 80.[5]

Fig. 81.[6]

(3.) The periosteotome takes many forms (Figs. 80, 81); it is always a blunt instrument and in its use care must be taken not to contuse the periosteum when it is desirable to preserve its function.

[1] T. Billroth. [2] G. Buck. [3] W. Parker. [4] G. C. Blackman.
[5] H. B. Sands. [6] L. A. Sayre.

(4.) The bone-cutting instruments are numerous and important. The straight bone forceps[1] (Fig. 82) is a most useful instrument

Fig. 82.

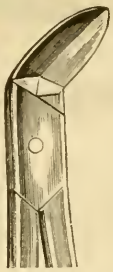


Fig. 83.

Fig. 84.

Fig. 85.

Fig. 86.

in the section of the small bones, wherever it can be brought to bear. But frequently it is quite difficult to reach the part, which may be more readily divided with the forceps than the saw, unless the blades are curved at a considerable angle; in such cases a forceps curved (Fig. 83, or Fig. 84) will be found serviceable. The bone gnawing forceps (Figs. 85, 86), or rongeur, is indispensable in many resections, as it enables the operator to remove projecting parts not accessible to other instruments. The saw in one of its various forms is necessary. The chain saw (Fig. 87) consists of a number of pieces, with movable articulations, terminated at each extremity by handles with which it is worked.

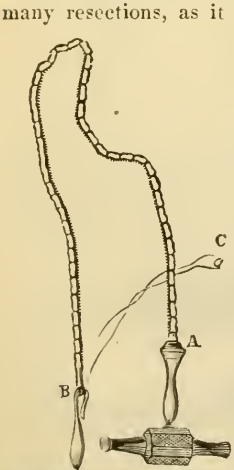


Fig. 87.

To use this saw one handle is removed from hook, B, and a needle, C, armed with a strong thread, is attached to this end; the needle is passed under the bone, and the saw drawn into its position, with the cutting edge upwards, and the handle is then reattached; the operator, grasping the handles, draws the saw alternately from side to side, until the bone is divided; there is great danger of breaking this saw if it is worked carelessly; it should be drawn from side to side steadily, at an angle of 45° to the long axis of the bone. The sections may consist of metallic beads strung on a wire with handles; such a saw will act efficiently in whatever direction it is held.[2]

Other saws, of peculiar shape, are often useful in the removal of certain bones, though not absolutely essential; the saw (Fig. 88) with a movable back,

[1] R. Liston. [2] Tiemann & Co.

may be used to advantage in most resections of bones of the extremities; in the removal of the superior maxilla, the right and left bone saws (Figs. 89, 90) enable the operator to separate its superior

Fig. 88.

attachments with great facility; a small straight saw (Fig. 91) is often required and when it is necessary to use a part of the edge, an India-rubber tube may be drawn over the part unused to prevent its in-

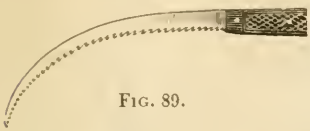


Fig. 89.

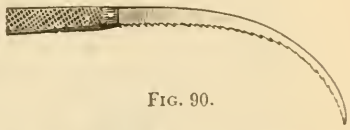


Fig. 90.

juring the soft parts; occasionally a saw having a circular as well as a straight edge [1] (Fig. 92) is required in removing sharp points, or thin

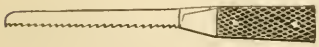


Fig. 91.

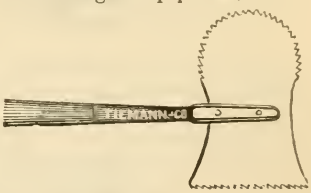


Fig. 92.

bones; finally, a saw [2] is essential, which may be taken from its position (Fig. 93) where it is firmly held by a spring, connected with the

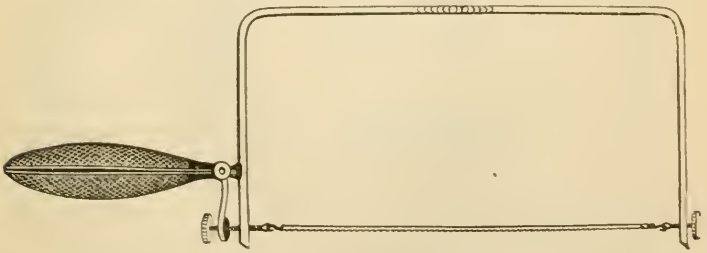


Fig. 93.

handle, and passed under the bone, if required, and the ends, being reattached in the frame, the bone is as readily divided from beneath

[1] R. Hey. [2] R. Butcher; Symanowsky.

as from above; the saw may be turned laterally also, or be made to cut in a curve; the tension of the saw is regulated by a spring inclosed in the handle. The gouges, the chisel (Fig. 94), and the mallet (Fig. 95), are often required; to thoroughly clean out all

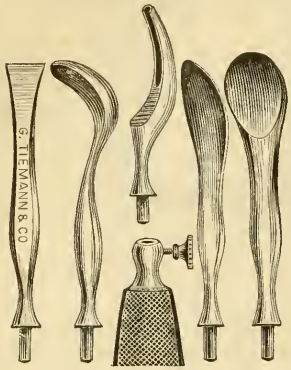


Fig. 94.[1]

Fig. 95.

forms of carious cavities, two or more gouges are necessary with different cutting edges; the mallet may be of wood or metal with a firm handle. (5.) The seizing forceps may be the common dressing forceps (Fig. 96) for small fragments, and larger forceps for large

Fig. 96.

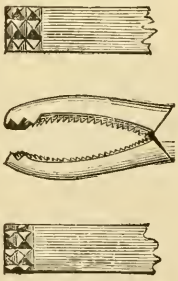


Fig. 97.[2]

Fig. 98.

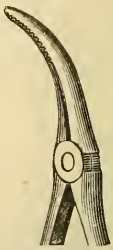


Fig. 99.

fragments (Fig. 97); they should also have straight and curved beaks (Figs. 98, 99) to seize fragments that are concealed. Other instruments may be used, as the conical screw, the térefond.

4. **The operation** is as follows: The anæsthetic having been administered, the elastic bandage should be applied unless there is in-

[1] J. T. Darby. [2] Sir W. Fergusson.

filtration of the cellular tissue with fluids, in which case it should be omitted.[1] The method of operating must be adapted to each particular case. In shot fractures the extirpation of fragments must be through openings extending from the wound; in necrosis the sinuses are guides for incisions; in the removal of the bone for morbid growths, the incisions must be largely in the direction of the tumor. The incision in general should be made as nearly as possible over the bone to be removed, and distant from important blood-vessels and nerves; the soft parts should not be destroyed, except so far as they have undergone degeneration, or interfere with the proper closure of the wound; injuries to blood-vessels and nerves lying in the track of the incision should be scrupulously avoided by drawing them aside; muscles and tendons should, if possible, not be divided, nor their attachments incised, but should be separated to the least practicable extent with a blunt instrument. The bone being exposed to the desired extent, the next care of the operator should be to preserve in the wound, and, as far as possible, in its original position, the periosteum of the bone to be removed, in order to the reproduction of sufficient new bone to preserve the function of the part.[2] The periosteum is best preserved by first incising it to the extent of the bone to be removed, and then separating it with the periosteal knife. The periosteum being separated, the bone must be divided by cutting forceps or the saw, and each portion separately removed; if the saw is used, the soft parts should be carefully protected by compresses or a spatula introduced underneath it. In some cases the interior of carious cancellated bones may be scooped out, and the external shell be left as the basis of new bone.[3] The scoop may be a curved chisel, the periosteal knife, or other instrument which may be applied to the interior of the carious cavity.

6. **The treatment of resection wounds** should secure rest and freedom from all sources of irritation. Rest is obtained by apparatus which is adapted to each case; in general the immovable apparatus of plaster of Paris is most available and useful. These wounds necessarily heal by granulation, and hence are to be treated the same as open wounds. They are peculiarly liable to be poisoned by septic ferments from the putrefactive matters already existing in the wound. The dressings should therefore be scrupulously antiseptic throughout the stage preceding granulation, and subsequently to such degree as will protect the granulations from any infectious matter which may enter or form in the wound. First, wash and cleanse the wound thoroughly with a carbolic acid solution, 1 to 20; then fill it from the bottom with masses of lint saturated in carbolized oil, 1 to 20; renew the dressings every twenty-four to forty-eight hours,

[1] F. Esmarch. [2] L. Ollier. [3] C. Sédillot.

carefully picking out with the dressing-forceps each mass of lint, but without bruising the surfaces so that they bleed, and refilling the wound with newly-prepared lint saturated with the oil; when the surfaces are well covered with granulations, change the carbolized oil dressing to balsam of Peru, a mild but efficient antiseptic [1] application to granulations.

BONES OF THE UPPER LIMBS.

Resection is to be preferred to amputation, in the greater number of lesions of the upper extremities, as the principal function is that of mobility.[2]

1. **The phalanges** may be resected in part or whole, but the results are not always favorable, owing to the stiffness, shortening, and deformity which so often follow. Efforts should be made to preserve the periosteum with a view to the production of new bone in the shafts of the bones that have been removed. In the after treatment, apply a splint to the palmar surface, and make such extension as will maintain the full length of the phalanx: The entire phalanx is removed by an incision over the shaft of the bone on the side; the tendons being raised, introduce the bone forceps, divide the bone, and remove the two halves separately at their articulation. In removing the third or ungual phalanx, make on the palmar surface a double T incision, one end corresponding to the articulation, the other to the extremity of the finger; denude the phalanx from the end towards its base, the nail remaining intact. The shaft of a phalanx may be removed by a longitudinal incision made on the dorsal or lateral aspect of the phalanx; detach the tendons with bone forceps, held at right angles to its long axis; divide the shaft in two places equally distant from its extremities, and remove the fragments or dorsum.

2. **The metacarpal bones**, when resected for shot injuries, give a large mortality, confirming the precept [3] that operative interference should not be thought of in such cases.[4] For diseases, the excision frequently gives favorable results. The superficial condition of the dorsal aspect of these bones, and the important anatomical relations of their palmar surface, require that all operations for their excision be commenced on the posterior part or dorsum.

(*a.*) The entire bone is removed as follows: Make an incision along the dorsal surface of the third and fourth metacarpal bones, and on the radial side of the second and ulnar side of the fifth; draw the extensor tendon on one side, and relieve the sides of the bone of the soft parts; separate the periosteum as much as possible, and

[1] E. R. Squibb. [2] C. Sédillot. [3] F. Stromeyer. [4] Geo. A. Otis.

divide the centre with the bone forceps (Fig. 100), or with the chain saw, the soft parts being protected by a compress or spatula; the fragments are then separately elevated, and disarticulated with the point of the knife.[1]

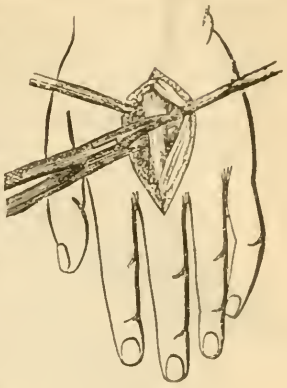


Fig. 100.

This operation may be variously modified, according to the condition of the part affected. When there is much swelling, make a short lateral incision at each extremity of the longitudinal cut.[2] The incision may also be made between the tendons of the long and short extensors on the dorsum along the radial border.[3] In resection of the fifth metacarpal the cut may be a T or L.[2]

(*b.*) The shaft is removed by a longitudinal incision on the radial border of the first and second, on the ulnar border of the fifth, and the dorsal surface of the third and fourth; carefully avoid the extensor tendons, and with a chain saw divide at two points the denuded bones.

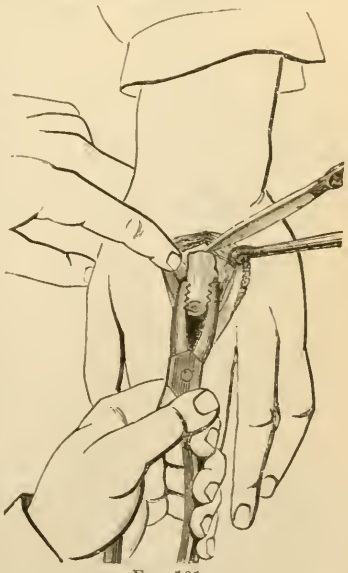


Fig. 101.

(*c.*) The proximal portion of the bone is resected by a longitudinal incision over the upper extremity of the metacarpal bone; avoid the extensor tendon, separate the soft parts from the sides of the bone; divide the bone at the requisite point with bone forceps, or with the saw, after being isolated from the soft parts, and as far as possible from the periosteum; seize the fragment with the forceps; raise it from its bed (Fig. 101), and disarticulate the joint with the point of the knife.

(*d.*) In complete resection the extremity of the metacarpal bone is removed and its corresponding carpal bone, by a single longitudinal incision made in the direction of the superior extremity of the metacarpal bone, which is denuded of soft parts, and sawn

[1] E. Chassaignac. [2] C. Sédillot. [3] A. Guériu.

at the proper point; remove this part at its articulation, and then extirpate the carpal bone.

(*e.*) The phalangeal extremity of the metacarpal bone of the thumb is removed thus: Make an incision on its dorsal surface; draw aside the extensor tendons carefully; divide with a chain saw at the required point; seize the diseased portion with the forceps (Fig. 102), bring it forward, expose the articular extremity to the point of the knife, by which it is readily disarticulated.

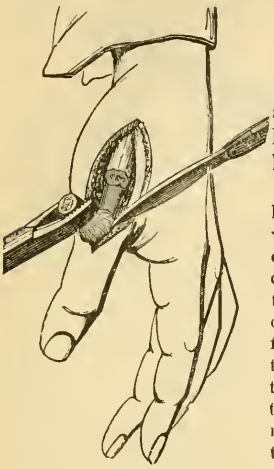


FIG. 102.

Or, make an oblique incision, commencing half an inch beyond the point at which you wish to apply the saw, from the middle of the dorsal surface of the metacarpal bone to the commissure of the finger, then another from the same point to the next commissure on the other side; thus circumscribing a V-shaped flap, with its base next the finger; turn aside the extensor tendon, detach the interossi from the sides of the bone, and open the joint, cutting its anterior and lateral ligaments carefully, not to wound the flexor tendons; then dislocate the phalanx backwards.

In total resection the incision should be dorsal, except[1] for the first, second, and fifth metacarpo-phalangeal articulations; in opening these the incision should be lateral, as the operator will thus avoid exposing the extensor tendons; the two articular surfaces being exposed, the ligaments are incised, and the bone either sawn with the chain saw, or divided with the bone forceps (Fig. 103).

FIG. 103.

Or, make two incisions, beginning at the middle of the dorsal face of the metacarpal bone, diverging on either side to the commissure of the finger, and forming a V-shaped flap, with its base towards the finger.

3. **The radius** may be resected for necrosis with excellent results, the mortality being small, and the usefulness of the hand and wrist being well preserved.[2] In shot injuries operative interference increases the mortality.[3] In the after treatment secure rest by a wire, tin, or sole-leather splint applied to the inner surface of the arm and forearm, and use carbolized oil dressings.

(*a.*) The lower extremity is broad, of a quadrilateral form, having two articular surfaces, one concave, on the lower part, for articulation with the scaphoid and semilunar bones; the other on the inner

[1] E. Chassaignac. [2] J. M. Carnochan. [3] G. A. Otis.

side, narrow and concave, to articulate with the lower end of the ulna.

The anterior and posterior ligaments are attached to the margin of the joint, the lateral ligament to the styloid process; the posterior surface has grooves for the passage of the tendons of extensor muscles; the outer surface of the styloid process has grooves for tendons, and its base gives attachment to the supinator longus muscle; the pronator quadratus muscle occupies the lower fourth of the anterior surface.

Resect as follows: make a longitudinal incision along the radius on its external anterior border (Fig. 104), extending downwards to a point opposite, and a little behind, the styloid process (*b*); if necessary, add two terminal incisions at the extremities of the first one, extending transversely backwards, about three quarters of an inch; dissect so as to expose the bone on its different aspects; make section of bone by means of the chain saw; separate the diseased portion from the soft parts, and isolate the lower part of the radius from its attachments at the radio-carpal articulation, without injury to the artery (*a*), nerves, or tendons. In many cases it will suffice to make a simple straight incision along the radial border, over the part parallel with its long axis.

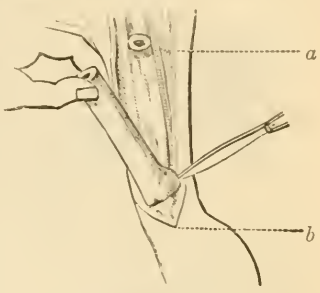


FIG. 104.

(*b.*) The shaft is resected thus: make a long straight incision on the external aspect of the bone, parallel with its shaft; separate the muscles, and, drawing the lips of the wound apart, denude the bone; pass the chain saw, divide the bone at the two points selected, and raise the fragment from its bed.

(*c.*) The head of the radius is quite superficial on its posterior part and surrounded by the orbicular ligament, which retains it in the lesser sigmoid cavity of the ulna. Resect by making a straight incision on the posterior and external part of the arm over the bone, divide the bone cautiously, and raise it from its articulation by cutting the ligaments with the point of the knife.

(*d.*) The entire radius may be excised; make an incision along the outer surface of the radius from the styloid process to the head of the bone at the elbow joint; divide the fascia along the outer border of the supinator longus muscle, and separate the muscles along this line down to the bone; incise the periosteum the length of the wound, and separate it from the bone; divide the bone in the middle and remove each extremity separately.[1]

[1] L. Ollier.

4. **The ulna**, like the radius, may be resected for necrosis with very favorable results, both in regard to mortality and usefulness of the limb; but for shot injuries the mortality is in the aggregate augmented by operative interference.[1] The after treatment is the same as in resections of the radius.

(*a.*) The lower extremity articulates on its external surface with the radius, but is excluded from the wrist-joint; it has an anterior and posterior ligament uniting it to the radius, and a lateral ligament connecting the styloid process to the carpus. Resection is as follows: the hand being carried outwards, make a longitudinal incision over the most superficial part of the extremity; dissect the periosteum from the bone to the required height, and carry the chain saw under the bone (Fig. 105); having divided the bone, proceed to dissect it from its articular connections.

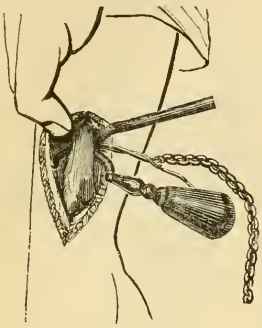


Fig. 105.

(*b.*) The shaft may be removed by a longitudinal incision on its posterior part, parallel with the bone, and external to its border; separate the muscles, detach the periosteum, make a section of the bone at the two points selected, and remove the included portion.

When a large portion of the bone is to be removed, make two or three separate incisions instead of one and remove the bone in pieces.[2] If the skin is diseased or redundant, make two very long and slightly curved incisions, with their concavities facing each other, as in circumscribing an ellipse; then dissect in front and behind, as far as the radial border of the bone, and saw the bone.

(*c.*) The upper extremity includes the olecranon which enters largely into the formation of the elbow-joint, but is subcutaneous. Resection is as follows:[3] make a longitudinal incision, five inches in length, over the middle of the olecranon, extending three inches above and two below it, penetrating to the bone; divide the triceps tendon at its insertion towards either edge, care being taken to avoid cutting across the aponeurosis, which is continuous from the edges of the tendon over the muscles lying on the posterior part of the forearm, and inserted into the edges of the olecranon; dissect up these insertions of the fascia, as well as the origins of the muscles beneath it, from the bone to the extent of nearly two inches, which allows the olecranon to be exposed, when the edges of the incision may be drawn asunder over the condyles; broad, curved spatulæ being used for this purpose; with the amputating saw cut through one half the

[1] G. A. Otis. [2] E. Chassaignac. [3] G. Buck.

thickness of the bone; complete the section with a fine saw, after which separate completely with a chisel and mallet.[1]

In some cases better access is secured to the bone by a T; in others by a crucial incision.[2]

(*a.*) The entire ulna may be removed by the following method:[3] rotate the limb inwards from the shoulder-joint, and carry the pronation of the forearm so far as to cause the palm of the hand to look directly outwards; slightly flex the elbow-joint and elevate the hand; this twisted position places the ulna upon the posterior and outer aspect of the forearm and renders it more easily accessible; the limb thus placed, the assistants maintaining the arm and forearm steadily, stand upon the right side of the patient, with a strong, straight, sharp-pointed bistoury make an incision along the posterior and inner aspect of the ulna, commencing at the lower part of its superior third and extending downwards to a point over the extremity of the styloid process, dividing the tegumentary layer and fascia; pull back the tendon of the extensor carpi ulnaris and expose the bone; make a transverse incision, about an inch long, parting from the lower extremity of the first incision, across the back of the wrist; reflect the superficial tissues and detach the tendon of the extensor carpi ulnaris carefully from its groove on the lower part of the ulna; now carry the dissection along the anterior surface of the lower portion of the ulna, and detach the soft parts from the bone as far as the interosseous ligament, the ulnar artery and nerve being carefully avoided; detach the soft parts from the posterior surface of the ulna, avoiding injury to the extensor tendons; divide the bone at the lower part of the middle third, and separate the lower fragment from its articular connections; prolong the incision upwards, along the posterior surface of the ulna, terminating at the upper part of the olecranon, opposite its outer edge; to this join a terminal incision transversely across the back of the elbow-joint, as far as the inner margin of the ulna; now dissect the soft tissues from the bone, upon its posterior and anterior aspects, as far as the interosseous ligament, and as high up as the insertion of the brachialis internus muscle; pass a knife, curved flatwise, close upon its interosseal margin, grazing the bone, and dividing the interosseal membrane upwards; the soft parts being held apart, and the interosseous and ulnar arteries protected; flex the elbow-joint now and open behind, by entering the bistoury close to the inner edge of the olecranon, divide the attachment of the triceps extensor by cutting directly outwards; protect the ulnar nerve; divide the lateral ligament and the attachments of the brachialis anticus muscle, the coronary ligament, and remove the bone from its articulation.

[1] S. D. Gross. [2] A. Velpeau. [3] J. M. Carnochan.

5. **The radius and ulna** may be removed together,[1] and if the periosteum remains, a useful limb may result. Make a straight incision the entire length of each bone on the dorsal surfaces, separate the muscles, and when the bone is reached, raise the periosteum and detach the articular extremities; keep the limb well extended during the after treatment.

(*a*.) The inferior portions are resected as follows (Fig. 106): The hand being pronated and held firmly upon some solid surface, make two longitudinal incisions along the borders of the radius and ulna, *a*, *b*, *c*, *d*; raise the soft parts on both surfaces, introduce the fine saw,[2] and after dividing, remove the extremities; if necessary, unite the lower extremities of these, *b*, *d*, and dissect the quadrilateral flap, *a*, *b*, *c*, *d*, thus circumscribed; turn the flap backwards and effect the disarticulation.

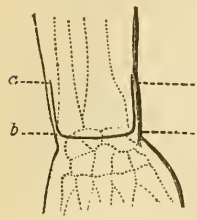


FIG. 106.

(*b*.) The superior portions of both bones may be removed by lateral incisions, joined by a transverse incision over the joint; remove the radius first, denude the bone, and divide with the chain saw; the head is disarticulated by dividing the attachment of the biceps, and the orbicular ligament; divide the ulna in a similar manner, and disarticulate, carefully guarding against injuring the ulnar nerve on its inner aspect, and the artery in front, and preserving if possible the attachments of the brachialis anticus muscle.

6. **The humerus** is generally resected in part, though it has been removed entire.

The mortality after resection for disease is comparatively small, but for shot injuries it is nearly double that in cases treated by expectant measures, and more than twelve per cent. higher than in a large series of primary amputations in the upper third of the arm.[3] The results of resection for disease are highly favorable as regards the functions of the limb, new bone rapidly forms and the shaft is firmly consolidated; for shot injuries the repair is much less perfect, as no bony union took place in upwards of twenty-seven per cent. of the recovered cases.[3]

The resected limb should be placed in a sole-leather splint moulded to the shoulder, arm, and elbow, and inclosing the limb, except along the course of the incision; make such extension as will maintain the proper length of the new-formed bone.

(*a*.) The lower extremity of the humerus presents on its anterior and posterior surfaces, depressions for corresponding prominences on the ulna; the articular surface is on a lower plane than the condyles, and the inner part descends lower than the outer.

[1] R. Compton. [2] R. Butcher. [3] G. A. Otis.

The flexor and extensor muscles of the hand arise from its condyles: it has anterior, posterior, and lateral ligaments; the brachial artery lies in front, and the ulnar nerve passes over the inner condyle on its posterior and external part.

Resect as follows: make a straight incision on the posterior and external part of the arm (Fig. 107) sufficiently extensive to give a free exposure of the bone, *a*, when the wound is separated; denude the bone and divide with the chain saw; raise the cut end with the left hand, or with forceps, and proceed to disarticulate with the point of the knife, carefully avoiding the brachial artery in front, and the ulnar nerve behind and at the inside.

b. Resection of the shaft requires the utmost care to avoid wounding the musculo-spiral nerve.

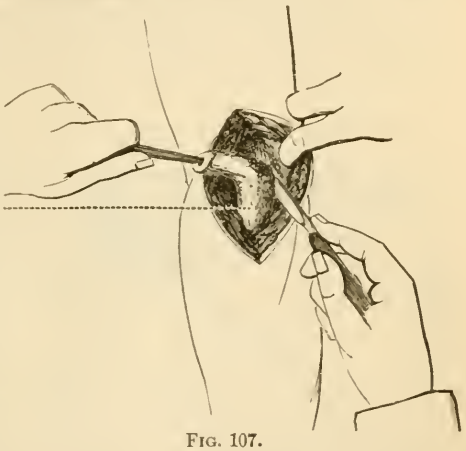


FIG. 107.

The lower half of the shaft of the humerus is closely invested with muscles, as the brachialis anticus and triceps; the upper half gives attachment principally to the muscles from the shoulder, chest, and back, as the deltoid, pectoralis major, latissimus dorsi, and rotators; the brachial artery, with the median and ulnar nerves, passes along the posterior margin of the biceps muscle, and the superior profunda artery and musculo-spiral nerve wind around the posterior and external part of the upper and middle portion of the shaft.

If the upper portion of the shaft is to be removed, make a straight incision on the external part of the deltoid muscle, care being taken not to extend the incision upwards so as to involve the circumflex artery and nerve; when the lower part of the shaft is excised the incision should be along the outer border of the brachialis anticus muscle, avoiding the musculo-spiral and external cutaneous nerves; the bone is readily exposed and removed to the required extent.

(c.) The upper extremity consists of the head surrounded by the capsular ligament, the tuberosities and shaft.

The subscapularis is inserted into the lesser tuberosity; the supra and infra spinatus and teres minor into its greater tuberosity; the long head of the biceps runs through the capsule; the deltoid covers the external surface of the joint.

Resect thus: make a straight incision, commencing a little above and outside of the coracoid process, and half an inch below the clavicle, and carry it downwards to the requisite extent along the deltoid muscle on the anterior part of the joint; the bone is here quite superficial, and is most readily exposed; the bicipital groove being found, dislodge the long head of the biceps muscle and draw it aside (Fig. 108 *b*); divide the tendons of the subscapularis, supra and infra spinatus, and teres minor — as they are made tense by rotation of the bone outwards and inwards; open the capsule and resect.

If the disease is limited to the head of the bone, the diseased structures may possibly be removed with the gouge, without involving parts beyond the capsule; if it is of greater extent, or if the operation is undertaken for fracture involving the upper part of the shaft, expose the bone at the proper place and divide with the chain saw; elevate the upper extremity, and disarticulate with the point of the knife. It is not advisable to remove merely the articular surface of the humerus by an oblique incision, but the whole head must be removed at the surgical neck.[1] In the various conditions which injuries create, other methods may be preferable, namely, a V incision,[2] having its base upwards, or a triangular flap[3] on the external part of the deltoid;[4] or a semicircular incision, commencing at the posterior margin of the acromium, and passing downwards and forwards five inches, and opening into the articulation above and behind; a U-shaped incision which includes the deltoid, isolation being effected with a spatula.[5]

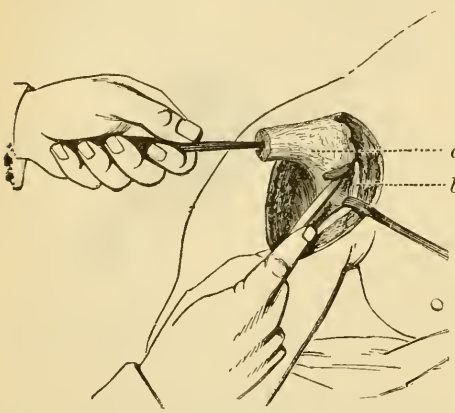


FIG. 108.

(*d*.) The entire humerus has been extirpated; in one case the thickened periosteum was left in the wound, but the patient died of internal disease, so that no decision could be made as to the usefulness of the extremity; in another case no new bone formed, but the patient had a useful arm supported by a ball and socket apparatus from the shoulder.[6] The incision must be the same as for the resection of the upper and lower extremity, avoiding carefully the musculo-spiral nerve.

[1] C. Heath. [2] Sabatier. [3] J. Syme. [4] F. Stromeyer. [5] J. E. Erichsen. [6] T. Billroth.

7. **The scapula** is resected for shot injuries, necrosis, and morbid growths. For shot injuries it is sometimes necessary to excise undetached portions of bone to facilitate the extraction of foreign bodies, and when there is great comminution it may be advisable to excise considerable portions of bone; there may be conditions also resulting from lacerations of large projectiles which would render primary extirpation of the scapula advisable; but as a rule it is better to wait, after removing detached fragments, the efforts of nature to consolidate the fractured bone, and resort to resection as an intermediary or secondary measure in cases of extended necrosis.[1] Resection for necrosis should involve extirpation of the entire bone, when the disease is very extensive, as it is unsafe to leave portions of a flat bone thus affected.[2] Extirpations of the entire scapula for morbid growths have proved so successful as to render it a legitmate operation.

The scapula gives attachment to a large number of muscles: to the internal surface, the sub-scapularis: to the external, the supra and infra spinatus; to the spine, the trapezius and deltoid; to the superior border, the omohyoid: to the vertebral border, the serratus magnus, levator anguli scapulæ, rhomboideus major and minor; to the axillary border, the triceps, teres major and minor; to the glenoid cavity, the long head of the biceps; to the coracoid process, the short head of the biceps, coracobrachialis, and pectoralis minor; it articulates with the humerus and clavicle; the subscapular artery, the largest branch of the axillary, descends along the outer border.

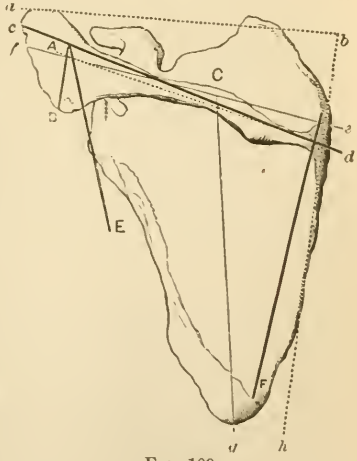


FIG. 109.

(*a.*) The body (Fig. 109) may be removed to a greater or less extent. Make three incisions, one over the whole length of the spine, A, *d*, and the other two extending from its extremities, one upwards to the root of the neck, A, *i*, the other downwards to the angle *d*, F; dissect the triangular flaps from the supra and infra spinatus fossæ, saw through the root of the acromion, and denude the posterior and anterior surfaces of the bone; reverse the body of the scapula from within outwards, and divide the part at the proper point with the saw.[3]

[1] G. A. Otis. [2] S. Rogers. [3] A. Velpeau.

Or make a longitudinal incision extending from the superior to the inferior angle along the vertebral border, F, *b*, a second parallel incision extending from the neck of the acromion to the middle of the external border, A, E; a transverse incision unites these along the spine; dissect the flaps, detach the muscles posteriorly and anteriorly, and divide the bone with the chain saw or forceps.

For a tumor, make an incision commencing at the superior angle of the scapula in a direction obliquely downwards and inwards; a second incision five inches below the upper end of the first, having a curvilinear direction terminating about the same distance from its lower end; dissect the integuments towards the axilla and spine, detach the muscles, separate the acromion and the neck of the scapula, and remove the bone.[1]

(*b*.) The spine, acromion process, and angles may be separately resected. The spine may be readily exposed, owing to its superficial position, by an incision made parallel to its border (*c*, *d*); if required, the incision may be curved downwards so as to raise a flap; the bone being denuded, the diseased portions may be removed with a strong cutting forceps. To resect the acromion [2] make a semilunar incision at the posterior part of the shoulder with the convexity downwards; pass the chain saw under the narrow part of the neck of the acromion, divide the bone at this part, and disarticulate; or make a crucial or T incision, or follow the track of sinuses which may exist. An angle of the scapula may be resected by a transverse, or a V, or a crucial incision over the part. In resection of a border, make the incision parallel with the part to be removed.

(*c*.) The entire scapula is removed as follows [3]: Make an incision from the acromion process to the posterior edge of the scapula (*f*, *e*,) and another from the centre of this one downwards (C, *g*); reflect the flaps thus formed, separate the scapular attachment of the deltoid, and divide the connections of the acromial extremity of the clavicle; to command the subscapular artery, divide and tie it without delay; next cut into the joint, and round the glenoid cavity, hook the finger under the coracoid process, so as to facilitate the division of its muscular and ligamentous attachments, then pulling back the bone forcibly with the left hand, separate its remaining attachments with rapid sweeps of the knife. The sub-periosteal resection may be made by the same incision.

The scapula may be removed by any of the methods given for the excision of a part of the body; other methods have been adopted, namely, a flap formed by the incisions *a*, *b*, and *b*, *h*; or A, *d*, joined at the extremities by *b*, *h*, and A, E.

8. **The clavicle** has such immediate relations to the upper walls of the thoracic cavity that operations for its extirpation must be cautiously performed.[4] In shot fractures, detached splinters should always be immediately extracted; but extirpation of the bone for

[1] S. D. Gross. [2] E. Chassaignac. [3] J. Syme. [4] V. Mott.

such injuries will seldom be required, though when the wound is uncomplicated by serious injury of the lung, nerves, or great vessels, it does not appear that the operation is necessarily fatal.[1] Necrosed bone should be cautiously removed in order not to injure neighboring parts. The removal of morbid growths involving the clavicle is sometimes the most serious operation in surgery.[2]

(*a.*) The scapular extremity is broad and flat, and gives attachment on its posterior part to the trapezius, and on its anterior to the deltoid; it is bound to the acromion by a superior and inferior ligament, and to the coracoid process by the coraco-clavicular, or coracoid and trapezoid ligaments. Resection is as follows: make a crucial incision, of sufficient length; raise the flaps, cut the attachments of the deltoid and trapezius muscles and acromio-clavicular ligaments.[3] Or, make a curved incision, with its convexity forwards and a little outwards, which, reflected backwards, completely exposes the bone; divide with the chain saw, seize it with the forceps, and divide the ligaments, raise the bone, and detach.[4]

For a tumor, make a crucial incision through the integuments and the platysma myoides, one limb nearly in a line with the clavicle, and the other at right angles, and dissect the flaps and facial coverings successively, down to the external basis of the tumor; carefully detach the pectoralis and deltoid muscles from their clavicular origin, avoiding the cephalic vein, and divide on a director the fibres of the trapezius and the cleido-mastoid muscles. Disarticulate the scapular extremity of the bone, and the mobility thus communicated to the mass facilitates the completion of the operation; pass a director beneath the bone, as near to the sternal articulation as practicable, and with a pair of strong bone nippers divide it; detach the subclavius muscle and rhomboid ligament.[5] Or, make an elliptical incision from the middle of the clavicle backwards, over the most prominent part of the tumor.[6]

(*b.*) The entire clavicle may be resected for necrosis: Make an incision parallel to its inferior border extending a little beyond its extremities; or add two vertical incisions, of one to two inches in length, one on the outside, the other on the inside of the first incision; the flap resulting from which divisions, on being raised up, completely lays bare the bone; then disarticulate either the sternal or acromial extremity, and grasp it with the left hand in order to raise it up, while with the right detach with the bistoury the adhesions upon its lower border; or saw the bone through its middle, and remove the two halves separately.

For a tumor operate as follows: Make an incision from the acromial extremity of the clavicle to the external extremity of the clavicle of the opposite side; cross this by an incision at right angles with it, beginning just below the middle of the sterno-mastoid muscle, and extending to the face of the pectoralis muscle below the middle of the clavicle; dissect the four flaps from the surface of the

[1] G. A. Otis. [2] V. Mott. [3] A. Velpeau. [4] E. Chassaignac.
[5] B. Travers. [6] J. Syme.

tumor; dissect the deltoid muscle from its anterior edge, and the trapezius from its posterior edge, and divide the coraco-clavicular ligament; pass the chain saw and divide the bone; seize the fragment with the forceps, and detach the soft parts with the point of the knife, the edge being kept constantly turned towards the bone, in order not to make the slightest wound of the soft parts.[1]

(*c*.) The sternal extremity is of a triangular form, and has the following important relations: —

On its postero-superior surface to the sterno-mastoid and sterno-hyoid muscles, and on its anterior surface to the pectoralis major muscle; posteriorly it is in near relation with the pleura, internal mammary artery, subclavian vein, and transverse cervical artery; the innominata is on the right, and the thoracic duct on the left side.

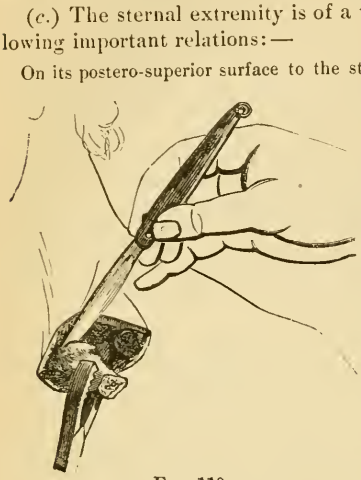


Fig. 110.

Resect as follows: Make (Fig. 110) an incision curved downwards, the degree of the curvature depending upon the size of the bone, but always so arranged as to enable the operator to raise it by dissection to the upper part; after raising the flap, instead of separating the muscles, pass a chain saw at the point where the bone is to be divided; remove the fragment by carefully disarticulating it with the point of the knife, and avoid wounding the important parts posteriorly.

For a large tumor, the following operation was performed: A semilunar incision, exposing the pectoralis major muscle, was made from the sterno-clavicular articulation, the extent of the tumor, and an incision was made from the outer edge of the external jugular vein, over the tumor, to the top of the shoulder, the platysma myoides and a portion of the trapezius divided, the bone exposed external to the coracoid process, and divided with the chain saw; another incision was made over the tumor from the sternal extremity of the clavicle to the termination of the first incision at the external jugular vein; in the subsequent dissection, owing to the large size of the tumor, the external jugular was tied, and the outer portion of the sterno-mastoid muscle was divided; the hæmorrhage was excessive.[2]

BONES OF THE LOWER LIMBS.

The lower limbs are employed in support and progression, and hence resections should be so performed as to preserve stability of the bones.

1. **The phalanges** of the toes may be resected by the methods

[1] J. C. Warren. [2] V. Mott.

given for the corresponding bones of the fingers. Resection of the shaft of a phalangeal bone may be by a straight incision on the dorsum, the extensor tendon being drawn aside; or the incision may be on the lateral surface of the joint and curved downwards; the bone may be divided with the forceps. The great toe is of the utmost value in progression, and in removing diseased bone every effort must be made to retain periosteum, with a view to the preservation of its function.

2. **The metatarsal bones** may be partially or entirely removed. (*a.*) In resection of the phalangeal extremity of the metatarsal bones, make a straight incision on the dorsum of the toe, over the part to be removed, avoiding the extensor tendons, divide the bone with forceps or saw, and disarticulate; in operating upon the first and fifth, the incision may be upon the free lateral surface, and it may be straight, or curved.[1] Resection of the extremity of the first metatarsal bone is made by an incision on the outside of the joint; denude the bone to the point at which it is to be cut, and saw it perpendicularly to its axis; then detach it from the soft parts, proceeding from behind forwards and complete the resection by separating it from the phalanx. (*b.*) In resection of the shaft of metatarsal bones, the same incisions are practiced on this part of the metatarsal bones as at the extremities; in removing the body of the first and fifth, a curved incision more completely exposes the bone (Fig. 111); the chain saw should be used to divide the shaft of the first metatarsal bone. (*c.*) The resection of the tarsal extremity of the metatarsal bones requires the same incisions as have been given for resections of the phalangeal extremities of the metatarsal bones. The chief obstacles in the disarticulation are the interosseous ligaments which unite the metatarsal bones together. The incision should freely expose the articulation, and the bone being divided, it should be raised with the forceps, and disarticulation effected with the point of the knife. (*d.*) The resection of entire first and fifth metatarsal bones requires a curved incision with its convexity downwards *a*, *b*, *c* (Fig. 111), and extending beyond the articulation; the bone being exposed, the middle of the shaft should be divided with the saw, and the fragments separately disarticulated. In the removal of the three middle metatarsal bones, a long straight incision should be made, the bone divided in its centre, and the operation completed as in the preceding case.

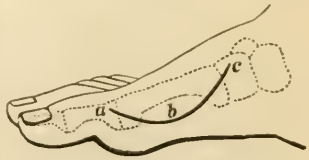


FIG. 111.

[1] E. Chassaignac.

3. **The tarsal bones** are very liable to be involved in the articular inflammations of that region, or to be separately affected by caries; in either case they may require removal, singly or in groups. The results have been in the highest degree favorable, both as to mortality and the usefulness of the limb. These operations have never been performed according to any prescribed rules, but each operator has adapted his incisions to the exigencies of the individual case in hand; in many cases the bones have not been resected entire, but the portion of bone diseased has been removed with a gouge. In the resection, care should be taken not to involve the synovial membrane of adjacent articulations, which do not communicate with the joint involved; and, whenever practicable, the periosteum should be preserved. The individual bones may be resected by the following methods, and by a combination of these incisions two or more bones may be removed at a single operation.

1. **The cuneiform** or wedge bones are placed at the fore part of the tarsus; they articulate behind with the scaphoid, and in front with the metatarsals of the three inner toes; the second bone is the smallest, and does not reach as far forwards, so that the second metatarsal is more deeply set in the tarsus. Resection[1] is as follows: Make an incision on the outer side of the foot, extending from the centre of the outer margin of the plantar surface of the os calcis to the middle of the metatarsal bone of the little toe, 1, 1 (Fig. 112); make another incision on the inner side of the foot from the neck of the astragalus to the middle of the metatarsal bone of the great toe, 1, 1 (Fig. 113); carefully

Fig. 112.

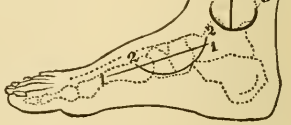


Fig. 113.

dissect off the dorsal and plantar surfaces from the outer and inner sides until the bones to be removed are completely exposed, the thumb of the left hand being the guide to the point and edge of the knife in keeping close to the surface of the bones, and avoiding injury to the important structures contained in the soft parts; insert between the soft parts and the bones a curved probe-pointed bistoury across the line of articulation between the astragalus, scaphoid, calcaneum, and cuboid, first upon the dorsal, then upon the plantar surface, and open up these joints; now introduce a key-hole saw between the plantar soft parts and the shafts of the metatarsal bones and cut them through, the handles of forceps or other body being inserted between the metatarsal bones and the dorsal soft parts to protect the latter. The wound must be firmly plugged with pledgets of lint, and the foot supported with properly applied splints.

2. **The cuboid** is situated on the outer side of the tarsus, wedged in between

[1] P. H. Watson.

the os calcis and fourth and fifth metatarsal bones: internally it articulates with the third cuneiform equally with the scaphoid; the inferior surface is grooved for the tendon of the peroneus longus.[1] Resect as follows: Make two incisions, 3, 3 (Fig. 112), one from the posterior extremity of the fifth metatarsal backward about two inches, the other of the same length from the same point along the dorsum inclining slightly forwards; raise this flap, and drawing aside the tendons of the peroneus longus and brevis, open the joints, and raise the bone with strong duck-bill forceps introduced from the free margin.

3. **The scaphoid** presents posteriorly a concave surface, as part of the socket of the head of the astragalus, anteriorly it has three facettes for the three cuneiform bones, externally it has a small facette for the cuboid, and internally it presents a free surface having a small tubercle.[1] Resect thus: Recognizing the tubercle, make a curved incision, the convexity downwards, extending from one inch posteriorly to the same distance anteriorly, 2, 2 (Fig. 112); raise this flap, and separate the soft tissues from both surfaces of the bone; with a strong knife, separate the joints anteriorly and posteriorly; seizing the bone with strong duck-bill forceps, raise and depress the bone, meantime detaching the ligaments with the knife.

4. **The astragalus** has most important connections; above it articulates with the tibia, laterally with the malleoli, and below with the calcaneum by two surfaces. It is attached to the calcaneum by the interosseous, posterior, and external ligaments; and to the scaphoid by a ligament passing from its anterior extremity. Resection may be made with slight injury to the tendons which pass over that region or by their destruction. The former methods are very tedious, but, unless sloughing occurs, give the best results. Resection is as follows: Make a superficial incision[2] from the tendon of the tibialis anticus, curved forwards and outwards to the middle of the scaphoid, thence backwards to a point below the external malleolus; raise the tendons and draw them aside, except the extensor brevis which should be cut; expose the bone, seize it with forceps, separate its attachments with the point of the knife, while the foot is strongly inverted. By the latter method, proceed as follows[3]: Make a curved incision from one malleolus to the other; lay the ankle joint freely open, exposing the whole upper part of the diseased bone; sever the ligaments attaching it to the scaphoid; raise the bone with a lever, and divide the interosseous ligament uniting it to the os calcis; clear the back part of the bone carefully to avoid injury to the tendons and vessels which lie near.

5. **The os calcis** has been frequently removed, and with marked success, as regards the mortality; the part remains very useful for walking and standing.[4] The bone articulates above with the astragalus by two articular surfaces having an interosseous ligament; in front with the cuboid, to which it is firmly bound by four ligaments, two plantars, which are very strong, a dorsal and interosseous. Resection has been made by numerous methods, but the plantar flap (Fig. 114)[5] gives ready access to the bone, and removes the cicatrix from the plantar surface. The patient lying upon his face, make a horse-shoe incision; carry it from a little in front of the calcaneo-cuboid articulation around the heel, along the sides of the foot, to a corresponding point on the opposite side; dissect up the elliptic flap thus formed, the knife being carried close to the bone, and thus expose the whole

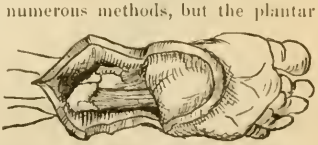


FIG. 114.

[1] L. Holden. [2] L. Ollier. [3] T. Holmes. [4] M. Polaillon. [5] J. E. Erichsen.

under surface of the os calcis; then make a perpendicular incision about two inches in length behind the heel through the tendo-achillis in the mid line and into the horizontal one; detach the tendon from its insertion, and dissect up the two lateral flaps, the knife being kept close to the bones from which the soft parts are well cleared; then carry the blade over the upper and posterior part of the os calcis, open the articulation, divide the interosseous ligaments, and then by a few touches with the point, detach the bone from its connections with the cuboid. Or, make an incision down to the bone from the inner edge of the tendo-Achillis horizontally forwards along the outer side of the foot, somewhat in front of the calcaneo-cuboid joint, midway between the outer malleolus and the end of the fifth metatarsal; it should be on a level with the upper border of the os calcis; make a second incision vertically across the sole of the foot from the anterior end of the former incision to the outer border of the grooved or internal surface of the os calcis.

4. **The fibula** may be resected in whole or in part with the best results.

(*a.*) The lower extremity articulates through the malleolus externus with the astragalus; it also articulates with the tibia by a convex surface, the joint being continuous with that of the ankle.

The ligaments are, the interosseous, which passes between the two bones, and is continuous above with the interosseous membrane; a flat triangular band extending between the two bones, anteriorly; the inferior ligament occupying the same position posteriorly; the transverse ligament extending from the external malleolus to the tibia.

Resect thus (Fig. 115): Make a straight incision over the bone the entire length of the diseased part; separate the periosteum, pass the chain saw, and divide bone; seize the fragment with the forceps, and resect.

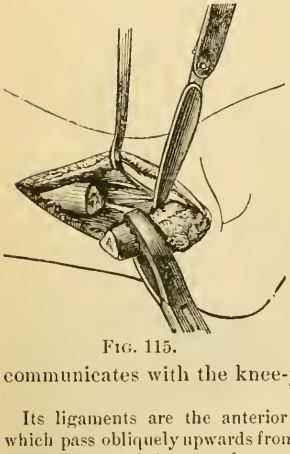


Fig. 115.

(*b.*) The shaft of the fibula gives attachment to muscles by all its surfaces, and by its internal border to the interosseous membrane; expose the bone by a straight incision, pass the chain saw, and divide the shaft at proper points above and below the disease.

(*c.*) The upper extremity of the fibula articulates with the external part of the head of the tibia; this articulation communicates with the knee-joint.

Its ligaments are the anterior superior ligament, two or three flat bands, which pass obliquely upwards from the head of the fibula to the outer tuberosity of the tibia, and the posterior superior ligament, a single thick and broad band which passes from the back part of the head of the fibula to the back part of the outer tuberosity of the tibia.

The resection is effected by the straight incision; divide the bone with the chain saw, raise the diseased part with the forceps, and effect the resection with the point of the knife.

(*d.*) In resection of the entire fibula make an incision parallel with the bone its entire length, separate the soft parts with the periosteum, and divide the bone in the centre with the chain saw; now disarticulate each fragment separately.

6. **The tibia** is subjected to resection more frequently than any other long bone, owing to its subcutaneous situation. The results are most favorable, as new bone is readily reproduced when the periosteum is well preserved.[1]

The tibia is bound to the fibula by the following ligaments: the anterior, a flat band of fibres; the posterior, somewhat triangular; the transverse, long and narrow, and below the posterior. The internal lateral ligament unites the lower border of the internal malleolus to the astragalus, os calcis, and scaphoid.

(*a.*) The lower extremity forms the upper and internal part of the ankle-joint; it is closely invested with tendons, and upon its postero-internal border the posterior tibial artery and nerve pass to the foot. Resection by the subperiosteal method of the entire diaphysis and lower epiphysis has resulted in reproduction of the bone removed and a useful limb.[2] Make a straight incision along the crest to the ankle-joint; saw the bone at the requisite height; raise the bone from its periosteal bed by carefully separating the periosteum; dislodge the tendons from their grooves, divide the ligamentous structures, and complete resection by detaching the bone from the articulation.

(*b.*) The shaft of the tibia is subcutaneous on the anterior and inner part; exsection of this portion is a comparatively simple operation; on the posterior part it gives attachment to muscles, and along its external border is attached the interosseous ligament connecting it to the fibula. The operation will depend upon the extent of the disease, and the location of the sinuses if the disease is necrosis. The incision should be along the subcutaneous borders of the bone, and extend beyond the diseased portion; the periosteum should be thoroughly separated from the shaft, and the bone divided with a chain saw at either extremity; the fragment is then easily separated.

Or, make a long curved incision in the length of the bone, having its convexity backwards; dissect this flap up and turn it outwards; divide the bone at the proper points, and raise the fragment with forceps. As excision of the shaft of the tibia is generally undertaken for necrosis, the gouge is found useful in separating dead bone, and the mallet may be used freely; it is also frequently desirable to use the trephine.

(*c.*) The upper extremity of the tibia is broad, and presents upon

[1] L. Ollier. [2] D. W. Cheevers.

its upper surface two cup-shaved cavities for articulation with the condyles of the femur.

The ligaments which are attached to it are, anteriorly, the ligamentum patellæ, internally, the internal lateral, posteriorly, the posterior ligament, or the ligamentum posticum Winslowii, and within, the anterior and posterior crucial ligaments.

The operative process is entirely subordinated to the degree, actual situation, and form of the disease; so that there may be occasion for the crucial, or the elliptical, or simple incision, and also for a variety of saws and bone-cutting instruments.[1] When practicable, subperiosteal resection should always be performed.

7. **The patella**, though in immediate relation with the knee-joint, may be excised with good results. Make a crucial incision, the transverse branch being over the base of the bone, or a second transverse incision may be made near the apex; dissect the flaps off cautiously, and remove the bone or its fragments; the tendinous expansion surrounding the bone should be separated, and not divided, as far as possible. The antiseptic method should be strictly pursued.

7. **The femur** is the largest bone of the skeleton. Resections of different portions of the bone are very frequent and give satisfactory results, especially when the periosteum is preserved, as new bone is reproduced.[2]

(*a.*) The lower extremity is rarely removed, except in exsections of the knee-joints. When it is necessary to operate for necrosis in this region, the sinuses are the safest guides to the dead bone. If, however, a formal operation is required, make a long straight or slightly curved incision on the external aspect of the knee, isolate the femur a little above the condyles, preserving the periosteum, and make section of the bone by the chain saw; the fragment is then made to protrude at the wound, seized with forceps, and disarticulated.

(*b.*) The shaft of the femur gives attachment to muscles throughout nearly its entire extent, and to reach it without injury to the soft parts, the muscular septa must be followed, either along the antero-external region of the limb, or as indicated by the seat of the disease; the curved incision and the semilunar flap raised up from without inwards, and from behind forwards, may sometimes be necessary to lay bare the bone to a sufficient extent. The limb must be well supported by the gypsum or other dressing during the after treatment.

(*c.*) The trochanter major gives attachment to the gluteus medius and minimus, and by its fossa to the external rotators. In resection make a free crucial incision through the skin and tendon of the gluteus maximus, and when the surface is sufficiently exposed, use the

[1] A. Velpeau. [2] T. Holmes; J. Bell.

gouge to scoop away the affected parts; if the disease prove extensive, divide the attachments of the glutei to the upper and fore part of the process, and then remove the entire trochanter with saw and forceps.

(*d.*) The upper extremity of the femur enters so largely into the exsections of the hip-joint that the methods of removal are essentially the same.

BONES OF THE TRUNK.

The bones of the trunk form the walls of cavities containing vital organs, and give support to the limbs; resections are, therefore, generally partial, and must be performed with such care and by such methods as will not impair these functions.

1. **The vertebræ** have been subjected to frequent partial resections. The removal of loose fragments after severe injuries, as from shot, are perfectly rational, and have resulted in a fair measure of success.[1] Resections of the arches or trephining the spine, is one of the most difficult[2] and fatal operations in surgery, and practically without benefit. Eighty-five per cent. of terminated cases have proved fatal, and there is no well authenticated case of complete recovery.[3] The conclusion is inevitable that without much more positive favorable evidence, resection of the arch cannot be accepted as an established operation.[1]

If resection is attempted, proceed with the operation as follows:[4] make a long incision above the ridge of the spinous processes, the middle of which is opposite the displacement; divide all the attachments of the muscles to the articular processes; as one end of each muscular bundle is separated from its attachment, it retracts and needs little holding back; the saw or the nippers are generally sufficient to divide the vertebral arch; in sawing or cutting out the arch, grasp the spinous process, if it be not broken, with a pair of stout tooth forceps, which are to be preferred to the elevator for lifting the detached bone from its natural connections; a small crowned trephine may be used to cut through the vertebral arch, or Hey's saw.

2. **The sacrum** may be partially resected for the relief of pressure upon nerves as follows: Make a crucial incision; remove the spinous process of the bone with forceps and Hey's saw; apply a trephine, and make an opening, through which introduce bone nippers, and remove the bone.[5]

3. **The coccyx** may be excised in whole or part for necrosis, fracture, and a painful affection, coccydinia, thus: place the patient on the side, the thighs flexed, and the hips close to the edge of the bed; the buttocks being separated, make an incision in the median line, extending from the extremity of the coccyx upwards to the

[1] G. A. Otis. [2] P. F. Eve. [3] J. Ashurst, Jr. [4] J. F. South.
[5] G. C. Blackman.

requisite extent; remove the diseased bone either with the gouge, or the drill, or the bone may be divided with the cutting forceps. The forefinger in the rectum determines the progress and extent of the resection.

4. **The ribs** are closely invested on their internal surface by the pleura, and along the groove on the lower border runs the intercostal artery. The only admissible primary interference when the ribs are fractured by balls is the extraction of loose fragments, and the smoothing off of sharp-pointed ends.[1] Resection for necrosis should be made by opening existing sinuses and carefully separating the thickened periosteum with the pleura. In the removal of morbid growths, portions of ribs may require resection; great care must be taken to separate the pleura with the periosteum without wounding the former. Proceed as follows: Place the patient upon the sound side, and expose the bone by an incision along the middle of the rib, or the incision may be curved downwards; divide the intercostal muscles and disengage the intercostal artery from its groove in the inferior border of the bone; separate the pleura cautiously with the handle of the scalpel, or similar instrument, and pass a thin piece of pasteboard or other substance behind; divide the bone with the chain saw. Section of the posterior part of the rib may be first made to avoid wounding the pleura; scrape carefully each border of the bone, and do not incline the point of the knife towards the intercostal space. In removing the false ribs, support the free extremity while the rib is divided posteriorly.

Or, make a curved incision having its convexity downwards, exposing the diseased bone, two or three days before resection; after having cut the flap pass two threads firmly united, by means of a curved needle along the internal face of the rib at the point where the bone is to be divided; replace these threads after twelve or twenty-four hours by a drainage tube; these tubes prepare the way for the passage of the chain saw; on the second or third day saw the bone and remove the fragment.[2]

5. **The sternum** has been frequently partially resected for shot injuries, and with very favorable results, the mortality being very slight.[3] When subperiosteal resection has been made for necrosis, new bone has been reproduced.[4] The incision for resection may be crucial or vertical, according to extent of injury or disease, and the parts may be removed by the trephine, gouge, or forceps.

BONES OF THE FACE.

In resection operations on the bones of the face it is important to avoid, as far as possible, incisions which will leave unsightly scars, and the removal of bones which destroy the symmetry of the features. When practicable, perform intra-buccal resections without

[1] G. A. Otis. [2] E. Chassaignac. [3] O. Heyfelder. [4] L. Ollier.

external incision;[1] make incisions along the natural folds of skin and preserve the borders of the mouth from division;[2] in all cases that admit of subperiosteal resection, this method is to be preferred.

1. **The inferior maxilla** is very liable to injury and necrosis, and to be the seat of morbid growths. In comminuted fractures the fragments should be preserved unless quite detached, as they have great vitality, and are important in the preservation of the contour of the jaw. For necrosis the resection should as far as possible be subperiosteal and intra-buccal, and both objects may often be accomplished by occasionally aiding the slow process of separation of the necrotic bone from its attachments to bone and periosteum with the elevator, or the handle of the scalpel, or a spatula.[1] By degrees the sequestrum is loosened, new bone forms around it from the periosteum, and eventually the dead bone may be lifted from its bed with perhaps slight incisions of the gum; by this method large portions of the jaw, and even the entire jaw, may be reproduced during the process of sequestration, and not only its contour but its function be preserved.[1] This method is preferable to early resection, which is liable to be followed by great contraction of the parts, even if the periosteum is preserved and new bone is produced.[3] In resection for tumors ample external incisions are often required, and large portions of the bone must be sacrificed. But small tumors, involving only the alveolus, may be removed with bone forceps without incision of the skin.[4] A considerable portion of the central part of the jaw may be removed without incising the lip, if the mucous membrane is freely divided between it and the bone, and the lip is drawn well down.[4]

(*a.*) When the entire central part is to be resected proceed as follows: Pass a stout ligature through the tip of the tongue to hold it in position when the muscles are incised; an assistant standing behind the patient holds his head firmly, and compresses the two facial arteries at the points where they cross the lower jaw: standing in front, seize with the left hand one of the angles of the lower lip, while an assistant holds the other angle from the bone, and the whole in a state of tension: divide the lip with a vertical incision through the median line down to the os hyoides: or, if practicable, make a single curved incision along the lower margin of the jaw; raise the periosteum from the bone to be removed; extract a tooth opposite to each point where bone is to be sawn through; use a small Hey's saw, or the chain saw; the bone being sawn through on both sides, divide the muscles attached to it, as closely as possible to their insertion, carrying the knife along the concave surface.

[1] J. R. Wood. [2] Sir W. Fergusson. [3] Von Langenbeck; M. Rizzoli. [4] C. Heath.

Unite the two flaps with silver wire sutures passed through to the mucous membrane adjusting the margins of the lip; or use the hare-lip pins with figure-of-eight suture, if there is much tension; attach the ligature holding the tongue to a fold of adhesive strip firmly fastened.

Commence the incision at the angle of the mouth opposite the healthy portion of jaw; extend it down to the place at which the saw is to be applied; then along the base of the jaw past the middle line to the other point of section.[1]

(*b.*) The horizontal portion has the following anatomical parts to be considered: —

Attached on its internal surface is the mylo-hyoideus muscle, beneath which is the fossa for the submaxillary gland; on its external surface along its lower margin is the attachment of the platysma myoides muscle, and along its alveolar margin the buccinator; the facial artery mounts over its lower border, just anterior to the insertion of the masseter muscle.

Resect as follows:[2] Make an incision commencing behind and a little above the angle, avoiding the facial nerve and parotid duct along the border of the jaw, terminating from a quarter to half an inch below the symphisis menti; raise and reflect the flap on the face, tying both ends of the divided facial artery; the bone being denuded, or the periosteum raised, divide with a chain saw passed at the proper point anteriorly, a tooth being removed if necessary; seize the end of the fragment with strong forceps, and divide with the chain saw at or near the angle, as may be required; close the wound firmly with silver wire sutures, care being taken to compress the surfaces of the incised mucous membrane closely to secure prompt union.

(*c.*) The half of the lower jaw has the following additional relations: —

The rami terminate in two processes, one for articulation, and the other to give attachment to the temporal muscles; the articulation is supported by an external and internal lateral ligament, and the capsular; the stylo-maxillary passes from the styloid process to the angle of the jaw; the internal maxillary artery passes behind the neck of the condyle in such proximity as to render care necessary to avoid wounding it in disarticulation of the jaw.

Resect as follows (Fig. 116): Place the patient with the shoulders raised and head turned to the opposite side; commence the incision at the zygomatic arch behind the condyle, carry it downwards behind the ramus to the angle, and under the body of the bone to a point one quarter of an inch below the symphisis menti if the operation is for an old necrosis,[2] but through the centre of the lip (Fig. 116), if for the removal of bone for other affections; in the former case incise the periosteum and raise it from the bone throughout,

[1] J. Bell. [2] J. R. Wood.

but otherwise for the removal of a tumor;[1] the facial artery must be cautiously divided and secured; sub-periosteal resection may now be rapidly performed for necrosis, the bone being divided with the chain or small straight back saw, and the cut end used as a lever to raise it from its position during the process of enucleation; if the periosteum is not saved, having divided the bone *d*, seize the cut extremity, with forceps, raise it from its bed, carefully separating all tissues adherent to the body and ramus; carry a probe pointed bistoury or curved scissors beneath the zygomatic arch, and behind the coronoid process, and with it divide the tendon of the temporal muscle while depressing the bone to disengage the process and luxate the condyle; pull the bone *c*, strongly outwards, as far as possible from the vessels, in order to avoid especially the internal maxillary artery, *e*, and complete the operation by dividing the pterygoid muscles and the articular ligaments. Secure every bleeding vessel, and close the wound by carefully adjusting the margins of the integument and of the mucous membrane.

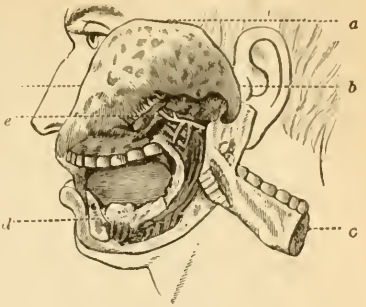


FIG. 116.

When the tumor is large and completely wedged in the upper part of the bone so as to hinder the freeing of the coronoid process, and prevent dislocation, cut off the tumor as high as possible with the bone forceps or saw, and then remove the remaining portion of the jaw only in case the disease is malignant.[1]

(*d.*) The entire lower jaw is removed as follows: Pass a ligature through the anterior part of the tongue, and intrust to an assistant; make an incision commencing opposite the left condyle downwards towards the angle of the jaw, ranging at about two lines in front of the posterior border of the ramus, thence along the base, to terminate at the median line a little posterior to the most prominent part of the border of the jaw. Dissect[2] upwards the tissues of the cheek, and reflect downwards, for a short distance, the lower edge of the incision; separate the tissues forming the floor of the mouth, situated upon the inner surface of the body of the bone, from their attachments from a point near the median line, as far back as the angle of the jaw; next divide the attachments of the buccinator; secure by ligature the facial artery, the sub-mental and the sub-lingual; expose the external surface of one branch of the jaw, and of the temporo-maxillary articulation, by dissecting the masseter upwards as far as

[1] C. Heath. [2] J. M. Carnochan.

the zygomatic arch; seize the ramus and pull the coronoid process downwards below the zygoma; divide the insertion of the pterygoideus internus, grazing the bone in doing so; carefully avoid the lingual nerve, here in close proximity; divide the dental artery and nerve; separate the tissues attached to the inner face of the bone, as high up as a point situated about a line below the sigmoid notch, between the condyle and the coronoid process; detach the tendon of the temporal muscle by means of blunt curved scissors, a probe-pointed bistoury keeping close to the bone; make use of the ramus, now movable, as a lever to aid in the disarticulation of the bone; to effect safely the disarticulation of the condyle, penetrate the joint by cutting the ligaments from before backwards and from without inwards; the articulation thus opens sufficiently to allow the condyle to be completely luxated; blunt scissors may now be used to cut carefully the internal part of the capsule, and the maxillary insertion of the external pterygoid muscle; by a slow movement of rotation of the ramus upon its axis the condyle is detached and the operation completed. To effect the removal of the other half, make the same incision on the opposite side, so as to meet the first on the median line; the dissection is similar.

2. **The superior maxilla** has the following important anatomical features:[1] —

It is attached to other bones in but three principal points: first, by its ascending process and articulations with the os unguis and ethmoid; second, by the orbital border of the malar, as far as the spheno-maxillary fissure; third, by the articulation of the two maxillary bones with each other and palate bone; there is a fourth point of contact behind with the pterygoid process and palate bone, which yields easily by simple depression of the maxillary bone into the interior of the mouth; in attacking these different points no large vessel is injured; the trunk of the internal maxillary artery may be easily avoided, or in any case tied after the removal of the bone; moreover, in case of unforeseen hæmorrhage during the operation we have a resource in compression of the carotid; only one important nerve trunk, the superior maxillary, need be divided.

Resection of the bone is performed for the extirpation of malignant growths and to gain access to naso-pharyngeal tumors; in the former case it is justifiable, only where the disease is limited to the upper jaw and its corresponding palate bone, owing to the certainty of recurrence if the disease extends beyond.[2] The methods of procedure are numerous, and give great and desirable latitude[3] to the operator. Early operators cut boldly through the cheek,[4] 1 (Fig. 118), but, to avoid unsightly scars, the rule now obtains of making the incision in the course of natural folds of the skin, 2 (Fig. 118)[3], and 2[5] and 4[6] (Fig. 117). Subperiosteal resection may be made by

[1] J. F. Malgaigne. [2] J. Bell. [3] Sir W. Fergusson. [4] Lizars.
[5] E. Nèlaton. [6] A. Guerin.

these incisions, but a more formal operation is made by dividing the cheek, 1 (Fig. 117).[1]

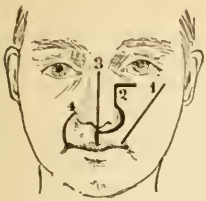


FIG. 117.

FIG. 118.

Resect the superior maxilla below the floor of the orbit[2] (Fig. 119), by the following operation: Make an incision slightly convex backwards commencing at the ala of the nose, and terminating at the corresponding commissure of the lip, following the naso-labial fold or furrow, 4 (Fig. 117); dissect up the two flaps resulting from this incision until the nostril is exposed, and the malar process is completely denuded; with a small saw held in the right hand, *a*, saw through the malar process from above downwards, and a little from within outwards; the soft palate having been detached from the posterior border of the palatine bone by a transverse incision made at the posterior border of the last great molar, and an incisor tooth having been extracted, divide the horizontal portion of the maxilla from before backwards with cutting forceps *c*, one branch being in the mouth, and the other in the nares; make a section of the bone from the divided malar process to the nares by the forceps *b*; seize the bone with strong forceps, and remove, fracturing the pterygoid process.

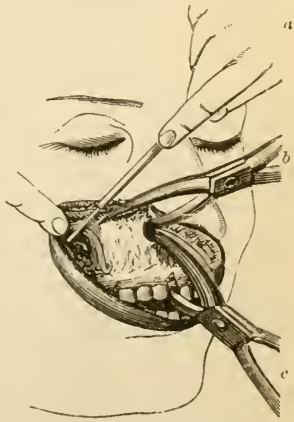


FIG. 119.

The entire maxilla or portions may be resected as follows:[3] Extract the incisor teeth of that side; divide the upper lip in the median line to the nostril; continue the incision around the ala and up the

[1] L. Ollier. [2] A. Guerin. [3] Sir W. Fergusson.

side of the nose, towards the inner canthus of the eye, thence continue it in a slight curve below the orbit, 2 (Fig. 117[1]), or, to the malar bone, 2 (Fig. 118); reflect the skin from the bone, and with a narrow saw passed into the nostril divide the alveolus and hard palate; incise the mucous membrane of the mouth as far back as the soft palate; with a narrow saw passed into the nostril divide the alveolus and hard palate; cut partially also the malar process of the maxillary bone, or, if necessary, the bone itself, and the nasal process of the superior maxilla, and complete the division of these bones with the forceps; grasp the bone with the lion forceps, and detach it forcibly from the pterygoid process and palate bone; when the bone is loose, raise the fascia of the orbital palate, separate the infra-orbital nerve, the soft palate, and any adhering tissues. The hæmorrhage must be suppressed by ligatures and the actual cautery, and the wound adjusted at the lips by hare lip-pins and in other parts by the wire suture.

Resection may be necessary by an incision through the cheek[2]: Make an incision with its convexity downward, 1 (Fig. 118) from the commissure of the lips to the temporal fossa; dissect this large flap from below upwards, and turn it back upon the forehead; cut through with the forceps the external orbital process at its juncture with the malar bone, the zygomatic arch, the os unguis, and the ascending nasal process of the upper jaw: divide the soft parts which connect the ala of the nose to the maxillary bone, and separate the maxillæ in front with a chisel and mallet, or a small saw; detach the soft parts from the floor of the orbit, divide at once the superior maxillary nerve, and the connections of the bone with the pterygoid process; conclude the operation by cutting through with the bistoury, or curved scissors, the velum of the palate, and the remaining soft parts which still adhere to and retain the bone. The chain saw may be used to divide the processes.

Resection without external incision may be made as follows[3]: The head being thrown back in position, and the mouth kept open by the gag placed between the back teeth of the opposite side, place a sponge cut so as to completely fill up the passage to the throat, and hold it in position on the soft palate by a sponge-holder to prevent the blood passing into the throat during the first part of the operation, the patient being allowed to breathe only through the nose; make two internal incisions from behind, half an inch on each side of the fangs of the molars forward to the central incisor of the opposite side; denude the periosteum with the elevator by commencing externally at the central incisor, and passing backward to the internal pterygoid process, and upward to the malar bone; then internally from the same point to and a little past the centre of the palate; the sponge now being of no further use, remove it; denude the tensor-palati muscle from its attachment to the posterior part of

[1] E. Nélaton. [2] A. Velpeau, J. Syme, R. Liston. [3] D. H. Goodwillie.

the hard palate; care being taken not to injure the posterior palatine vessels and descending palatine nerve that pass at this point forward on to the hard palate through the posterior foramen and along a groove; now extract the lateral incisor of that side, and by its socket though a little to the right of the centre of the hard palate, so as to save the vomer, make a section with a saw, dividing the superior maxillary bones; change this saw for one much shorter, the teeth of which have a different angle and the cheek falls into a U shank which allows the saw to play freely; make a section up between the tumor and the internal pterygoid process to the malar bone, then forward through the canine fossa, dividing also the inferior tubinated bone, to meet the other section at the ala nasi; after the saw has entered the antrum in this last section, the handle should be advanced more rapidly than the point; this prevents the point from piercing the vomer. By these two sections a tumor with adjacent bone may be removed clean.

3. **The superior maxillæ** may be removed at a single operation by an incision, 3 (Fig. 117), along the centre of the nose and through the upper lip; additional incisions may be made, if required, under the orbit laterally. Or, a four-cornered flap may be made by an incision on either side from the angles of the mouth to the external angles of the eye, 1 (Fig. 117).

III. TREPHINING.

This operation is required for the removal of a circular piece of bone, as in opening into cavities in bone. The instruments necessary are the trephine and elevator (Fig. 120). The trephine, *b*, *c*, *d*, is a cylindrical saw, with a cross handle like a gimlet, *a*, and a centre-pin, the perforator, around which it revolves until the saw has cut a groove sufficient to hold it; the centre-pin is then retired. The handle is fastened to the shaft by a screw, with a button affixed to the end of the shaft; or the screw may be on one end; when the handle is placed on the shaft this screw is tightened, and its extremity reaches the shaft and fastens it firmly in its place; the advantage of this arrangement is that the upper surface of the handle is smooth, and the palm of the hand is not bruised as it is by the handle of the old instrument. The conical trephine, *c*, has the peculiar advantage of dividing the osseous walls without any

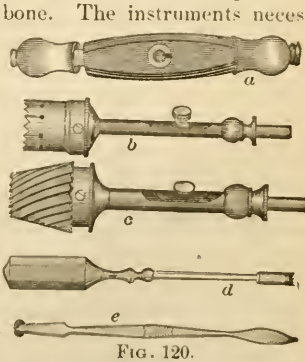


FIG. 120.

danger of wounding the structures within. It is a truncated cone, with spiral peripheral teeth, and oblique crown teeth; when applied, the peripheral teeth act as wedges so long as counteracting pressure exists on the crown teeth; upon removal of that pressure of the bony walls its tendency is to act on the principle of a screw; but owing to its conical form and the spiral direction of its peripheral teeth its action ceases. In the construction the trephine is made of different sizes to meet the various conditions in which it is used, as on the cranium, *b*, *c*, or for opening the antrum, *d*.

Trephining is performed as follows: Make an incision down to the bone, having the form of a V, T, or +, or of a semicircle; the bone being scraped, take the handle of the trephine in the right hand, and fixing the perforator by its screw so that it protrudes slightly beyond the teeth, place the perforator in the centre of the bone to be removed; work the instrument alternately backwards and forwards, until the teeth have cut a groove sufficiently deep to receive them; then loosen the perforator and fix it in the shaft, to avoid wounding the membranes; great care should be taken to maintain the instrument in a position perpendicular to the part operated upon, in order to avoid its penetrating more deeply on one side than the other, and thus suddenly and unawares wound the cerebral membranes. It is important to examine the depth of the groove frequently with a probe, to ascertain how nearly the instrument has completed the section of the bone; the teeth of the trephine may occasionally require cleaning with a small brush or wet sponge. The disc of bone should be raised with the point of the elevator *e*, and the edges smoothed with the lenticular knife at its other end.

IV. OSTEOPLASTY.

The transplantation of bone consists in raising bone, covered with its periosteum, and placing it in a new position for the purpose of filling gaps created by disease or operations. The superior maxilla has been resected so far as to permit the removal of naso-pharyngeal polypi, and been replaced with perfect restoration of its integrity;[1] portions of the hard palate have been cut away and placed in apposition with similar sections from the opposite in staphyloraphy;[2] the chasm between the fragments of ununited bone has been successfully filled by dividing the long axis, and turning it down so that it filled the space. The requisite to success is the preservation of the fibrous and periosteal attachments of the fragment removed to the bone from which it is separated.

[1] Von Langenbeck. [2] Sir W. Fergusson.

CHAPTER XV.

INJURIES OF JOINTS AND SPECIAL OPERATIONS.

Joints are composed of the two ends of bones covered with cartilage; of a sac frequently containing many appendages, pockets, and bulgings; of a synovial membrane, a fibrous capsule, and the strengthening ligaments.[1] It is owing to the intimate relations of these complicated structures that the injuries and diseases of joints are peculiarly serious.

I. WOUNDS.

On account of their exposed positions joints are specially liable to wounds of various forms and degrees of severity.

1. **Contused wounds** may be so severe as to be followed by extravasation of blood into the tissue around it, or even into its cavity. Examine first for a fracture, then apply apparatus to secure perfect rest, and the ice-bag to prevent inflammation; the gypsum dressing with a suitable fenestrum at the joint is the best apparatus for the injury of joints of the lower extremity.

2. **A punctured wound** is dangerous, owing to the tendency to suppurative inflammation and the retention of the pus. That the joint is involved is known by the escape of synovia. Pursue the following treatment: Place the patient in bed, close the wound with collodion or adhesive plaster, if it is slight, but with sutures accurately applied if it gape; secure perfect rest to the joint by immovable apparatus, and if any application is made, use cold. In favorable cases all excitement about the joint will subside in a few days, and when the dressings are removed at the end of four to six weeks, recovery will be complete.[1]

3. **An incised wound** is also recognized as having penetrated the joint by the appearance of synovia. Such a wound must be treated and dressed antiseptically; close it accurately with sutures, apply immovable apparatus to the limb, and locally use ice-bags; give cooling regimen. If the case proceed favorably, retain antiseptic dressings until union is firm, then commence passive motion, but restrict it for at least one month.

4. **A lacerated wound** should be treated as follows: Cleanse the wound of all foreign matters under the spray, pare the edges of all contused tissues, and if possible close the wound with silver wire sutures and treat it as an incised wound; if large, gaping, and cannot be closed under the carbolic spray, enlarge the opening wherever it

[1] T. Billroth.

is necessary to gain free drainage of the cavity of the joint, inject carbolic solutions, 1 to 20, to destroy septic ferments which may have entered the joint; introduce the drainage tube or a horse-hair drain, carbolized; apply antiseptic dressings and immobilize the joint by apparatus; renew the dressings within twelve hours, and repeat them as often as necessary to prevent accumulation of secretions in the wound.[1] However favorably the case proceeds, the joint must be retained in a state of perfect rest for at least two weeks, when passive motion may be begun, but if it produce any swelling of the joint or tenderness, all motion must cease for several days, when it may be renewed.

II. DISLOCATIONS.

A joint is dislocated when one bone is displaced from another at its place of natural articulation; there may be no other injury than rupture of the capsule, simple dislocation, or there may be a wound of the integument entering the joint, compound dislocation. The signs of dislocation are, preternatural immobility, and tendency, when reduced, to remain; but with free motion without crepitus. The treatment required is immediate reduction; anæsthetics must be used for relaxation; when reduction is possible by manipulation this method should always be preferred; if more force is necessary, make extension and counter-extension with the hands, aided with bandages tied in the form of the clove-hitch (Fig. 121); if more power is required, resort to mechanical contrivances, as the pulley. Compound dislocations are among the most serious accidents which can befall a limb;[2] but it must be borne in mind that by the proper use of antiseptic dressings these injuries may now be treated without suppuration, and are therefore far more amenable to conservative measures than formerly. The treatment must depend upon the amount of injury in each case; if slight, reduction may be effected by suitable enlargement of the wound, followed by thorough cleansing and disinfection; resection should be made when the bones are destroyed, the antiseptic dressings being employed; amputation will be necessary when the principal artery of the limb is ruptured, or there is destruction of the tissues about the joint, or the patient is old or feeble.

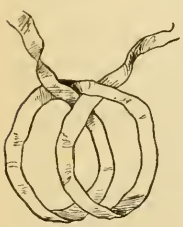


Fig. 121.

1. **The temporo-maxillary** joints are dislocated by the displacement of the condyles of the lower jaw forwards, one or both, the latter being more frequent. Reduce as follows: The patient seated on the floor with the head between the knees of the operator, place a

[1] J. Lister. [2] T. Bryant.

couple of pieces of cork, gutta percha, or pine wood as far back between the molars as possible; now draw the chin steadily upwards, taking care not to draw it forward at the same time; or, sitting or standing in front depress the condyles by means of the thumbs protected by pieces of leather placed on the tops of the molars; if this method fail, reduce one side at a time, or give an anæsthetic; after reduction support the jaw with a bandage.

2. **The vertebral articulations** are rarely displaced without fracture, especially in the lumbar and dorsal regions. In the cervical region forward and backward luxations may occur with or without fracture. Reduction should always be attempted. If the lumbar or dorsal vertebræ are displaced make forcible extension with judicious lateral motion and direct pressure upon the spine. If a cervical vertebra is displaced raise the head firmly by the chin and occiput, and if reduction does not follow, add slight rotation in the direction of dislocation to disengage the process, or place the patient on the back and make extension in the same manner.

3. **The sterno-clavicular joint** may be dislocated by the displacement of the end of the clavicle forward, upwards, or backwards. Reduction is effected by elevating the shoulder in pushing upward at the elbow, or by drawing the shoulders backward and upward with the knee pressing against the spine between the scapula. Though frequently it is difficult to retain the clavicle in position, the function of the arm is rarely impaired. For the first and second forms, the pad in the axilla, the sling for the elbow, and a pad upon the displaced bone, retained by adhesive straps, are most useful; for the third form, rest on the back, or such appliance as will retain the shoulder upwards and outwards, are required.

4. **The acromico-clavicular** joint may be luxated by the upward or downward displacement of the end of the clavicle; reduction is effected by drawing the shoulder outward and backward. The retaining apparatus for the upward luxation should be applied as follows:[1] Place a compress over the articulation, and retain it by two strips of adhesive plaster, the edges being glued to the skin by collodion; bandage the hand and forearm with a flannel roller; apply a loop of elastic bandage[2] five feet long and one inch and a half wide, passed under the elbow of the injured side; draw the ends snugly over the compress, carrying the anterior one around the axilla of the sound side, as in a spica of the shoulder, to join the other between the clavicles, where they are fastened with strong pins. Complete and permanent restoration rarely follows any treatment.[3]

5. **The shoulder joint** dislocations consist of the displacement of the head of the humerus; first, downwards into the axilla; second,

[1] W. T. Bull. [2] H. A. Martin. [3] F. H. Hamilton.

forward under the coracoid process; and third, backwards under the spine of the scapula. The reliable sign of these displacements is the projection of the elbow from the chest when the hand of the dislocated arm is placed upon the opposite shoulder. The method of reduction in the first two varieties is the same; proceed as follows: Flex the forearm upon the arm, and while the arm is elevated to a right angle with the trunk, rotate gently forwards by depressing the hand and forearm; or place the knee in the axilla to press the head outward and serve as a fulcrum, and use the shaft as a lever; or laying the patient down, place the heel against a pad in the axilla, and grasping the wrist and elbow, make steady traction, meanwhile prying the head outward with the heel; failing, give an anæsthetic.[1] Reduction may also be effected by manipulation: grasp the shoulder with one hand and the flexed elbow with the other, make extension at the elbow, drawing it from the side (Fig. 122) with slight rotatory motion outwards; when extension is fully made, raise the elbow and with the arm describe a semicircle towards the sternum and face, then suddenly depress the elbow upon the thorax, rotating the head of the humerus inwards and with the thumb of the right hand giving the proper direction to the head (Fig. 123); this manœuvre may be repeated if necessary.[3] In the subspinous form make extension towards the joint, or resort to the last method, standing behind the patient and drawing the elbow backward and rotating the bone while the thumb of the right hand guides the head to the joint. In compound dislocation the question as to the propriety of reduction or resection should be decided as follows: In a healthy patient, without complications, reduction is preferable; but if the patient is weak or old, or the exposed bone is badly injured, or the parts are much lacerated, saw off the exposed head of the bone.[4] Antiseptic dressings should be scrupulously applied.

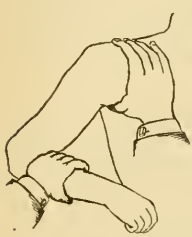


FIG. 122.[2]

FIG. 123.[2]

6. **The elbow joint** may be dislocated by displacement of the ulna and radius backwards, forwards, inwards, outwards, the last two being partial. Examine carefully to determine whether there is a transverse fracture of the humerus, or of one condyle, or of the olecranon. Reduce the first form thus: the patient seated in a chair, press the knee in the bend of the elbow and flex the arm forcibly but slowly around it.[5] Other methods are as follows: the pa-

[1] F. H. Hamilton. [2] T. Bryant. [3] H. H. Smith. [4] T. Holmes.
[5] Sir A. Cooper, F. H. Hamilton.

tient being seated, carry the arm and forearm directly backwards, the scapula being pressed forwards;[1] extension of the forearm from the hand or wrist downwards;[2] extension of the forearm from its middle by an assistant, while the surgeon seizes upon the olecranon process with the fingers of one hand and placing the palm of the other against the front and upper part of the forearm pulls forcibly backwards.[3] The second form may be reduced by forced flexion aided by pressure; the lateral displacements are restored by moderate extension combined with lateral pressure.[4] The head of the radius may be displaced separately forwards, outwards, and backwards, the first being far the most frequent; reduction is effected in all forms by extension aided by pressure upon the head of the radius made in the right direction.[4] In compound dislocations in healthy patients, reduce the bones and close the wound antiseptically, unless there is much comminution, when excision of the bones involved should be performed; in general, a useful limb results from these excisions of the joint surfaces.

7. **The wrist joint** is luxated by displacement of the carpus forwards or backwards; reduction is made by extension in a straight line with slight rocking or lateral motions if necessary.[4]

8. **The phalangeal joints** may be dislocated and are generally easily reduced. The displacement of the first phalanx of the thumb upon its metacarpal bone is an exception; the difficulty of reduction is due to the escape of the head of the metacarpal bone between the two tendons of the flexor brevis, where it is lodged as in a button-hole.[5] Reduction is effected by first pressing the metacarpal bone firmly to the centre of the palm to relax the short flexor, then putting the displaced phalanx in a state of extreme extension to relax the tissues of the button-hole and to push up those which form its distal part over the projecting head of the metacarpal bone; this is done by dragging the hyper-extended thumb downwards or away from the wrist, and then acute flexion will restore it to its place.[6] If this method fail, with a very narrow bladed tenotome divide the insertions of the flexor tendon and repeat the manœuvre.

9. **The hip joint**[7] is protected and strengthened by the ilio-femoral, or inverted Y ligament, which is inserted above into the front and outside of the inferior spinous process of the ilium, and below into the anterior inter-trochanteric line; it has two main branches, extending, the outer to the trochanter major, and the inner to the trochanter minor; in regular dislocations this ligament is unbroken and controls largely the movements of the head of the femur. The several positions of the head of the bone with reference to the socket may be reduced to the following, namely, (1.) The dorsal, including

[1] R. Liston, J. Miller. [2] F. C. Skey. [3] J. Pirre. [4] F. H. Hamilton.
[5] Fabbri. [6] T. Holmes. [7] H. J. Bigelow.

that on the tuberosity, the dorsal, the everted dorsal, the anterior oblique, and the supra-spinous. (2.) The thyroid, including that on the perineum and on the thyroid foramen. (3.) The pubic, the pubic and sub-spinous. Though the head of the bone may be primarily luxated in various directions, yet the downward dislocation is by far the most common, as the capsule is thin and weak at this part, and flexion, by which the ligament is relaxed, with adduction or abduction, is the habitual attitude of the thigh in action and self-defense. From this position the head of the bone readily passes to the dorsal, or thyroid, or pubic regions; thus all regular dislocations may be secondary. These several positions are sufficiently well recognized for reduction by the following sign, namely: the head of the femur always faces the same way as the internal condyle. As a preliminary to reduction, etherize the patient to relaxation, and place him recumbent on the floor. The best general rule for reducing a recent dislocation is to get the head of the femur directly below the socket by flexing the thigh at about a right angle, and then to lift or jerk it forcibly up into its place. This rule applies to all dislocations except the pubic, and even to that when secondary from below the socket; the reduction by the lifting method is usually instantaneous, and flexion is the basis of its success (Fig. 124). If after one or two trials it appears that the bone cannot be jerked into place, enlarge the rent in the capsule a little by moving the flexed thigh from one side to the other so as to sweep the head of the femur across below the socket; and again repeat the act of lifting. The following rules for reduction of the femur from its several positions, should be observed: (1.) In dorsal dislocations, flex and forcibly lift; if this effort fail, flex and lift while abducting. If this fail it will be found that abduction has carried the head of the bone from the dorsum nearly or quite to the thyroid foramen, and that the capsular rent has been so enlarged that the first method may now prove successful. (2.) In thyroid dislocations, adduction of the flexed thigh reverses this movement and carries the head from the thyroid foramen to the dorsum, and also enlarges the opening, making the first rule effective. (3.) The pubic dislocations may generally be brought down without difficulty from above the socket, after flexion, especially if they are secondary, and may then be reduced from that position like the thyroid.

FIG. 124.

A fulcrum made by rolling one or more sheets into a firm band, two or three inches in diameter, may aid the manipulator. Place the centre of the band in the groin, and while assistants raise the ends by pressure at the knees, the head

is lifted into the socket.[1] The same result is secured by requiring an assistant to lift the head of the bone by means of a stout sheet in the groin and over his shoulders.

10. **The patella** may be displaced outwards, inwards, or on its own axis; reduction is made by laying the patient on the floor, lifting the limb with the heel upon the shoulder so as to relax completely the quadriceps muscle, and pushing the patella into position; if this effort fails in the last form flex the thigh and straighten the leg while pressure is made on the patella.[3]

11. **The knee joint** is dislocated by displacement of the tibia backwards, forwards, outwards, and inwards, but in general the luxation is incomplete. Reduction is generally effected without much difficulty. If backward, use forced and extreme flexion; if forward, reverse the movement; if lateral, make extension and pressure.

12. **The ankle joint** is luxated by the displacement of the tibia forwards and backwards. Reduction is effected by extension and counter-extension combined with pressure. Division of the tendo-Achillis has been found necessary in cases of backward luxation. Dislocation outwards or inwards is a rotation of the astragalus, accompanied usually with a fracture of the fibula and rupture of the internal lateral ligament.[2] Compound dislocations are not infrequent at the ankle-joint, and always demand the most judicious care; as in other compound dislocations the conditions present must determine the course of procedure. By conservative measures in young and healthy persons, where the vessels have escaped damage, and there are no other serious complications, the limb and joint may often be saved. The wound should be cleansed of all foreign matters, carbolic solutions, 1 to 20, should be injected into all its recesses, and antiseptic jute or cotton, soaked in carbolized oil, applied to the opening; the joint must be immobilized by the fenestrated gypsum bandage, unless there is great swelling, when the splint must be used. Anchylosis will ensue, but the increased mobility of the transverse tarsal joint will in a great measure compensate for this loss.[3] When there is much comminution removal of the fragments is necessary, or excision of the joint may be required, followed by the dressings already given. In a certain proportion of cases, the injury, or health, or age of the patient, renders amputation the only safe course.

13. **The tarsal bones** may be luxated from their positions, but generally the great violence which causes such displacement does severe injury to the tarsus. Luxations of the astragalus are far the most important; the dislocations of this bone may be forwards, backwards, outwards, and inwards, or it may be rotated on its axis. As a rule, if the dislocation is simple, attempt immediate reduction; if

[1] G. Sutton. [2] F. H. Hamilton. [3] T. Holmes.

the luxation is complete and reduction impossible, resect; if the luxation is compound, resect; if there is severe laceration, or other injuries complicating these conditions, amputate. Reduction is effected by extension from the foot, grasped as in removing a boot, and counter-extension from the knee, with such pressure upon the displaced bone as may be required. If the astragalus is displaced from the scaphoid and calcaneus the treatment is the same.

CHAPTER XVI.

DISEASES OF THE JOINTS AND SPECIAL OPERATIONS.

It may be stated as a general truth that diseases of a joint commence either in the synovial or osseous tissues, and that they originate for the most part in an acute or chronic inflammation; in the progress of any case both tissues may become eventually involved; practically there is no primary disease of articular cartilages, and when they undergo a change it is secondary to some other affection, either of the synovial membrane or of the bone; when the disease commences in the synovial membrane or in the bone, and disorganization of the joint follows, it is in that tissue in which the disease began that the gravest change will be seen.[1]

I. INFLAMMATION.

Injury in some form is generally the cause of inflammation of the joints. The various wounds already mentioned are liable to terminate in inflammation, announced by swelling and heat of the part, pain on pressure, and fever.

1. **Serous synovitis**[2] commences with swelling, heat, and pain of the joint, but slight fever; the synovial membrane is slightly swollen and moderately vascular; the cavity is full of serum with synovia, and the remainder of the joint is healthy. The symptoms rapidly subside with rest, painting with the tincture of iodine, or applying compresses of wet bandages, or blisters; the patient soon begins to use the joint without difficulty, the fluid is gradually absorbed and function is restored.

2. **Parenchymatous or purulent synovitis**[2] begins with a chill, high fever, extreme tenderness of the joint which is fixed, swollen, and hot; there is no fluctuation, but the whole limb is œdematous; the synovial membrane much swollen, red, and puffy; there is a little flocculent pus in the cavity, and the cartilage looks cloudy; the difference between the serous and purulent varieties is that in the

[1] T. Bryant. [2] T. Billroth.

former the synovial membrane is simply stimulated to secretion, while in the latter it is deeply affected. The treatment at this early stage is: (1) fixation of the joint by apparatus, in the most favorable position for subsequent use if anchylosis occur, anæsthetics being given if necessary; the gypsum is generally the most available, the limb being well protected by wadding to avoid strangulation; (2) the continued application of ice-bladders so as to effectually cool the entire joint. Before applying these dressings the parts may be thoroughly painted with tr. iodine. Opium and quinine should be given in such measure as will secure relief from the effects of pain and fever. If the disease subsides months may elapse before the inflammation entirely disappears, and great care is necessary to avoid a renewal of the disease by cold or injury. If the disease continues to progress abscesses form, the joint becomes more swollen, the fever is high, and inter-current chills occur, emaciation follows, with sleeplessness and prostration; in the joint there is a collection of thick yellow pus mixed with fibrinous flocculi, the synovial membrane is covered with dense purulent rinds under which it is very red and puffy, partly ulcerated; the cartilage is partly broken down into pulp, partly necrosed and peels off, the bone is very red or infiltrated. The limb being secured in immovable apparatus, with ample fenestræ, open the abscesses and the joint anti-septically, thoroughly cleanse with carbolic solutions, secure free drainage, and give opium, quinine, and nourishing diet liberally. The patient may recover under this treatment with anchylosis, or metastatic abscess may form in the lungs, liver, or other organs, and death ensue from pyæmia. Occasionally the inflammation extends uncontrollably in and around the joint, the suppuration involving the thigh and leg, followed by great exhaustion, fever, and chills. Recovery is still possible, but openings must be made to evacuate the pus, and strengthening remedies given.[1] The antiseptic treatment is most serviceable in such cases; every collection of pus must be evacuated; all septic matters removed and cavities cleansed with carbolic solutions, and antiseptic dressings applied.[2] The question of exsection or amputation may arise in severe cases and must be determined by the special conditions of each case.

3. **Chronic synovitis** may result from the acute form, or it may be chronic from the start and remain so. The joint is much swollen, without heat or pain, and fluctuates all over; the fluid collects chiefly in the mucous bursæ adjacent, especially at the knee, where the bursæ under the tendons of the extensors at both sides of the patella and in the popliteal space are greatly distended, while the capsule is less distinctly marked than in acute synovitis; the patient can often walk

[1] T. Billroth. [2] J. Lister.

easily, but much exercise is fatiguing and followed by increased effusion.[1] The cure requires rest to the joint, and change in the synovial surfaces. Rest may generally be best secured by plastic dressing, both in the upper and lower extremity. To effect a change in the synovial membrane apply blisters or iodine; if it still remains filled with fluid, it may be tapped with a fine trocar, and the fluid withdrawn; or, if the fluid return, to tapping add an injection of iodine. The arrest of secretion in the latter case is due to the shrinkage of the serous membrane caused by the action of the iodine, with the new formation of endothelium.[1] Tap the joint carefully with a fine trocar, and after the escape of the fluid, without admitting air, inject by means of a well-made syringe officinal tincture of iodine and distilled water, equal parts, or, if it is desired to be more cautious, take one of the former to two of the latter; be careful that no air enter the joint; allow the liquid to remain from three to five minutes, according to the pain induced, then let it escape slowly, close the wound, and envelop the joint with wet bandages; the operation is not free from danger and may terminate in purulent synovitis.[1]

II. CARIES.

Two forms of destructive ulceration occur in the articular extremities of bones, which are liable to seriously compromise joints.

1. **Simple caries**[2] attacks the articular ends of bones as a sequel of inflammation of other tissues of the joint; it sets in as soon as the cartilage which coats the articular surfaces is finally destroyed, and the bare bone is left projecting into the cavity of the joint; by mechanical violence minute portions of bone tissue are successively detached with the debris which surrounds them; the ulcer is invariably superficial, sharply circumscribed, and relatively smooth; it is commonly situated where the opposed surfaces are in contact with each other; though slow in its progress it causes extensive losses of substance followed by marked shortening and distortion of the limb. The first symptoms may be slight heat, pain, and swelling, followed in a few weeks by gnawing pains and starting of the limb at night from spasms of the muscles, great pain on rubbing the joint surfaces together, contraction of the limb; finally pus forms and abscesses appear with their attendant symptoms.[1] The indications of treatment are, (1) tonics, as syr. ferri iodid, and cod liver oil; (2) complete relief of the carious bone from pressure and friction by extension, with apparatus adapted to the special joint involved. If the caries extends, exsection or amputation may be required.

2. **Fungating caries**, fungous or scrofulous inflammation of a joint

[1] T. Billroth. [2] E. Rindfleisch.

may originate in the synovial membrane, or there may be a central or more rarely a peripheral caries in the spongy epiphysis of a hollow bone or in one of the spongy bones of the wrist or ankle which may perforate from within outward and excite synovitis; sometimes in the hip, knee, and ankle with the fungous proliferation of the synovial membrane, there is an independent proliferation under the cartilage and between it and the bone, which subsequently unites with that above, so that the cartilage lies partly movable between the two granular layers.[1] More commonly the disease commences as a non-suppurative inflammation of the adjoining epiphyses of two bones where they unite to form a joint; the hyperæmic medulla grows towards the joint, the bony trabeculæ melt away, the cortical portion becomes thin, the exuberant granulations protrude between the cartilage and bone; meantime, the synovial membrane and its connective tissue, the ligaments, and finally, all of the neighboring connective tissue inflames; a diffuse congestion occurs in the delicate, overlapping fringe of the synovial membrane, from which a membrane of young connective tissue overspreads the cartilage from its edges; the superficial layer of cartilage cells now take part in the inflammation, cells multiply, the capsules open, the young connective tissue forces its way in; finally, the ascending growth meets that which is advancing downwards, the two coalesce, and the cartilage is perforated.[2] The disease may terminate in resolution, and the parts recover, or pus may form in the joint or in the tissues around it, creating abscesses with sinuses; or the connective tissue may enlarge and degenerate into a firm, white, fibroid mass of colossal dimensions, stretching the skin all around the joint and shining through it with a whitish lustre, causing the so-called white swelling, tumor albus.[2] The external appearances of the affected joint depend upon the extent of participation of the parts around the joint in the inflammation; there may be no suppuration but a simple proliferation of granulations which shall lead to destruction of ligaments and displacement of bones; or suppuration may occur in the granulations or synovial membrane, or in the connective tissue; whatever swelling there may be around the joint is due, not to enlargement of the articular ends of bones which never swell in caries, but to the thickening of the soft parts or to osteophytes.[1] The disease is frequent in childhood.

When fungating caries attacks spongy bones, which are largely invested by articulations, as the carpals, tarsals, and vertebræ, the bone may be entirely dissolved by interstitial granulations growing all through it without any necessary accompaniment of the slightest trace of suppuration.[1] But in the great majority of cases there is a

[1] T. Billroth. [2] E. Rindfleisch.

purulent periostitis, especially of the carpal and tarsal bones, and the disease readily extends to the entire bone and its articular surfaces as it progresses; the sheaths of tendons become implicated, the skin ulcerates, giving exit to the pus, and the joints swell and lose their shape.[1] The atonic form of inflammation with slight vascularization which results in caseous degeneration of the new formation, the so-called scrofulous caries, is essentially a fungating caries.[2] It occurs chiefly in the spongy bones, the vertebræ, the calcaneum, and epiphyses of hollow bones, and readily combines with partial necrosis.[1]

The essential feature of treatment of a carious joint is perfect rest of the part, combined with open air, syr. ferri iodid. and cod-liver oil. Rest must be obtained either by position or apparatus. In the upper extremity both methods may be usefully resorted to, but in the lower extremity apparatus should be so employed as to prevent all injurious movements of the joint, and yet permit of that general exercise essential to the health of the patient.[3] The hip, knee and ankle-joints may be placed at rest, and efficiently protected by the gypsum bandage, but well-fitted apparatus gives more precision to the efforts to protect them and yet allows free out-of-door exercise. In the early stage this course may secure resolution; later it may be followed by fibrous anchylosis, to be relieved by flexion; finally, in the stage of suppuration it may result in bony anchylosis. At various stages of progress the question of exsection and amputation will be raised and must be determined. The apparatus necessarily varies at each joint, but the principle is the same.

THE HIP-JOINT.

At the hip the early symptoms are flexion of the thigh, wasting of the limb, pain in the region of the knee; the patient may still exercise freely for months, but often cries out at night from startings of the limb. As the disease progresses the thigh becomes everted, more flexed and fixed, and the patient uses the limb less freely or not at all; then the capsule ruptures, inversion and flexion follows, the head of the bone is displaced upwards, and in this position anchylosis occurs, or death from exhaustion. The long hip splint should be applied as soon as the disease is recognized, and be worn day and night while the symptoms continue. This splint may be made in a very inexpensive form, but that which best meets all indications is made and applied as follows: —

The long hip splint (Fig. 125) extends from the sole to the crest of the ilium, where it is connected to a pelvic band by a joint allowing flexion and exten-

[1] T. Billroth. [2] E. Rindfleisch. [3] H. G. Davis; L. A. Sayre; C. F. Taylor.

sion, abduction, and adduction, but properly regulated. Extension is made by means of a rack and pinion rod, sliding within a steel tube, moved by a key, and kept in position by a spring catching the teeth of the rack; counter-extension is made by means of two perineal pads fastened to the pelvic band with straps and buckles; at the knee-joint is a movable cross-piece for attaching a leather cap to steady and support the knee; at the bottom of the instrument is a foot-piece with a leather sole attached, to prevent jar in walking; a leather strap, passing under the foot, through apertures in the foot-piece, turns up an end on each side of the ankle, and fastens to buckles in adhesive strips, which prepare as follows: Cut two pieces of plaster, to reach from the waist to the foot, from three to five inches wide at the top, and from 1 to 1½ inches at the lower end, and divide tops into five tails, cut a piece about five inches long, from each centre tail, and add it to the lower ends of the plaster to strengthen them, then add two or more similar pieces at the same place and attach a buckle; apply the plasters against the lateral aspects of the leg, beginning about two inches above the internal and external malleoli with the ends having the buckles attached; the centre tails reaching the entire length of the leg and thigh, to the perineum and trochanter respectively; then wind the lower ends spirally around the leg up to the pelvis and afterwards the other two tails, which first cut down to just above the knee; this involves the limb in a complete network of adhesive strips, the leg having about one fourth, the thigh three fourths, which is found to be the proportion to protect the leg and knee equally from compression or strain; a few turns of roller bandage are then made around the ankle, just under the lower ends of the straps, to protect the flesh under the buckles, and then continued over the strips on the whole limb; the patient should be laid on his back, and great care ought to be taken that the pelvis is not inclined forward by contractions of the flexor muscles; should this be the case, elevate the leg until the lumbar vertebræ come near the couch and the spinal column assumes its normal shape; the instrument is then applied; the pelvic band ought to be loose enough to allow the pelvis to move freely in it; the anterior superior spine of the ilium ought to be above the pelvic band (Fig. 126): in applying the ankle straps leave a little space between the foot and the foot-piece so that in standing or walking the weight of the patient does not rest on the leg, but on the instrument; the perineal straps must be so adjusted that the patient sits firmly and comfortably upon them; when the apparatus is adjusted apply the key to the rachet and extend the splint until the patient gives evidence that the strain is sufficient.

FIG. 125.[1]

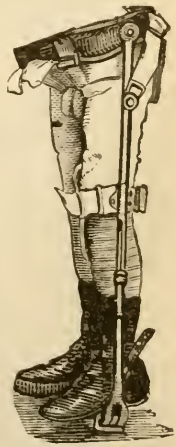


FIG. 126.

[1] C. F. Taylor.

THE KNEE-JOINT.

At the knee the disease causes at first but slight symptoms for months, as dragging of the leg or limping, pain after exercise, or on pressure; then there is swelling, the joint is evenly rounded, quite sensitive to pressure; gradually the joint becomes more and more angular and painful, so as to prevent walking; certain points become more painful and red with fever, fluctuation is detected, and soon after a thin pus, mixed with fibrinous cheesy flocculi, escapes; the symptoms at first improve, but soon another abscess forms with fever; these symptoms are repeated, attended by gradual emaciation, wasting and flexion of the limb; the disease may terminate fatally by extension, or recovery may follow with anchylosis of the affected joint. The knee-joint may be very firmly fixed, and still allow of exercise by the gypsum bandage applied from the middle of the leg to the middle of the thigh. An efficient brace[1] may be made of steel band and (Fig. 127) piece connected by extension rods, with rack and pinion (Fig. 128); or with gypsum bands above and below connected by two brackets (Fig. 129).[2]

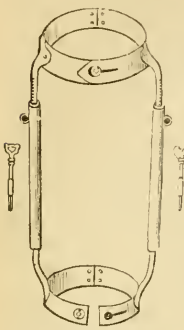


Fig. 127.

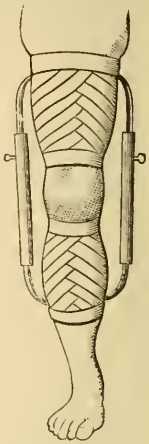


Fig. 128.

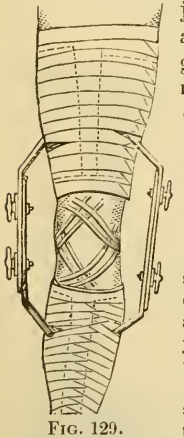


Fig. 129.

For the steel brace: Select adhesive plaster, spread on strong cloth and cut it in strips one inch wide, and long enough to reach from just below the knee to near the ankle, and also from the knee for several inches above the joint, upon the thigh. Secure these plasters to within an inch of their extremities by a snugly-adjusted roller (Fig. 128); place the instrument on the limb, the collars fastened sufficiently tight to be comfortable, and the loose ends of the adhesive plaster turned over them and secured by a roller; extend the connecting rods by turning the key.

The gypsum is applied above and below, and when hard the brackets (Fig. 129) are adjusted and fastened by additional layers.

THE ANKLE-JOINT.

Caries attacks the ankle-joint as a chronic inflammation, causing

[1] L. A. Sayre. [2] C. F. Stillman.

enlargement of the parts about the articular ends of the tibia, or malleoli, with the final formation of abscesses, and exposure of the joint. This joint may be very well protected by the gypsum bandage, applied from the toes to the middle of the leg. The ankle-brace may be of steel (Fig. 130),[1] or of gypsum (Fig. 131).[2]

Fig. 130.

The steel brace is applied[1] (Fig. 130), as follows: Cut adhesive plaster in strips about one inch in width and long enough to reach from the ankle to near the tubercle of the tibia, and placed all around the limb; secure the plaster in its position, to within an inch of its upper extremity, by a well-adjusted roller, as seen in Fig. 130: fix the instrument and secure the foot firmly by a number of strips of adhesive plaster.

In applying the gypsum brace, the foot, held at a right angle, is wound with plaster from the base of the nail of the great toe as far as the disease, and from above the ankle almost to the knee (Fig 131). The bracket is placed in position and bound down by repeated turns of the plastered bandage, taking care that the foot is still at right angles; the whole is neatly covered with clean fresh bandage.

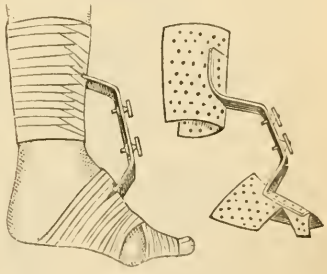


Fig. 131.[3]

CARPAL AND TARSAL JOINTS.

Carpal and tarsal caries is recognized in its early stages by swelling and tenderness of the part, and later by the displacement of the bones affected and the formation of abscesses with sinuses, through which the carious bone is detected. The general treatment is tonics with cod liver oil, good food, out-of-door exercise; locally tr. iodine should be employed with appliances which maintain perfect rest, and such extension as relieves pressure upon the diseased bones; the carpus may be maintained upon a well-padded palmar splint, with

[1] L. A. Sayre. [2] C. F. Stillman. [3] G. Tiemann & Co.

extension by adhesive strips applied to the fingers and attached to the projecting extremity of the splint; the tarsus is best immobilized by the gypsum dressing. In advanced caries (Fig. 132) setons of twisted oakum[1] are useful; they have the advantage of being disinfected with tar, and very porous; make opposite openings, so that the seton will traverse the diseased bone, pass the rope through and tie its ends together over the part; every day or two fresh oakum should be twisted into one end, then saturated with bals. Peru, and drawn into the sinus. Many cases will eventually recover under this treatment persistently followed; if it fail resection or amputation is a final necessity.

FIG. 132.

THE VERTEBRÆ.

Spinal caries usually affects the cancellous tissue of the vertebral centre, and results in a cheesy metamorphosis, beginning in the interior of the mass of granulations and gradually extending in all directions; these deposits, chiefly situated in the anterior half of the bodies of the vertebræ, soften into a pus-like fluid, which escapes by stripping off the periosteum, and the longitudinal ligaments of the column in front of which it accumulates, and then gravitate downwards; the intervertebral disks either escape the inflammatory changes altogether, or become involved at a relatively late stage of the disease; the result of the disorganization is relaxation of the union between the vertebræ, which favors dangerous displacements, as of the atlas, and angular curvatures.[2] The disease begins very insidiously with obscure symptoms referable to the nerves of the affected region; if in the lumbar region, there are pains in the legs and hypogastrium; if in the dorsal region, the pains will be in the epigastrium, and are frequently treated as indications of stomach and bowel derangements; if in the upper cervical region, the pains are in the chest or back of the neck and head. As the destructive ulceration progresses there is increasing weakness of the spine, with languor, inability to stand long erect, avoidance of all jarring movements, and if the upper cervicals are diseased, a disposition to support and protect the head with the hands applied to the chin and occiput; displacement in the form of a sharp posterior angle next appears, revealing positively the nature of the affection; finally, pus gravitating from the affected vertebræ accumulates as a congestive abscess beneath Poupart's ligament or in the lumbar re-

[1] L. A. Sayre. [2] E. Rindfleisch.

gion. The indications of treatment are, (1.) improvement of the general health; (2.) protection of the diseased vertebræ from injury; (3.) management of spinal abscesses. (1.) For the general health, tonics and good hygienic conditions are always required. (2.) Protection of the diseased vertebræ from the injury which the superincumbent weight of the body induces, requires judiciously applied apparatus. Of the various dressings employed the gypsum bandage is the most convenient and useful in general practice. It is designed to furnish an immovable apparatus which by uniform pressure around the entire trunk shall sustain the broken column in a fixed position. It is desirable to have the spine extended as far as the curvature will admit without undue tension of the diseased structures, and for this purpose the patient may be held, if a child, by the hands in the axillæ, or by adhesive strips applied to the front and back of the body and looped over the shoulder,[1] or by any means which secure extension of the spine, as lying face downward, with shoulders and hips resting on two chairs, the body being free. But more perfect results are obtained by using a suspending apparatus (Fig. 133) consisting of pulleys and cross-bar to elevate the body with an adjusted chin sling, and axillæ straps. The gypsum dressing is thus prepared and applied:[2]

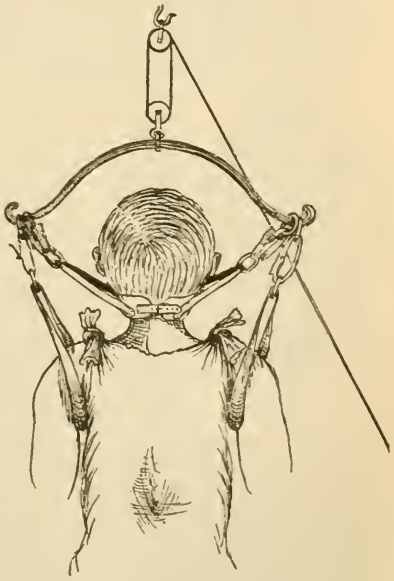


Fig. 133.

Select some loosely woven material, as mosquito netting, or crinoline: tear it into strips three yards long and two and a half to three inches wide, according to the size of the patient; draw them through very fine and freshly ground plaster of Paris which sets quickly, and rub the plaster well into the meshes; roll them up loosely; apply to the patient a tightly fitting shirt of elastic, soft woven, or knitted material, without arms, extending to the middle of the pelvis, and fastened over the shoulder by tabs; apply the chin-piece of the apparatus, place the arms in the axillary bands and raise the patient

[1] J. A Reed. [2] L. A. Sayre.

by the pulley gently and slowly, and never beyond the point at which he begins to feel uncomfortable, and which usually admits of the feet swinging clear of the floor; over the abdomen between the shirt and the skin place a pad composed of cotton folded in a handkerchief so as to form a wedge-shaped mass, the thin edge being directed downwards, its purpose being to leave a space after its removal when the bandage is firm for the expansion of the abdomen during meals; bandages, placed on the end in a basin of water until the bubbles cease to rise, are squeezed until the surplus water escapes and then passed round and round the trunk, beginning at the smallest part, and extending downwards a little beyond the crest of the ilium, then upwards in a spiral direction until the entire body is encased from the pelvis to the axillæ; pads of cotton are to be applied over any very prominent spinous process or other bony projections which may be inflamed from previous pressure, or liable to be irritated; if the patient is an adult female place pads over the breasts to be removed when the plaster is firm; the bandage should be placed smoothly but not tightly round the body, being simply unrolled with one hand and smoothed so as to be adapted to all the irregularities by the other; after one or two thicknesses have been applied, narrow strips of roughened tin or zinc should be placed on either side and parallel with the spinous processes, and others added at intervals of two or three inches until they surround the body; over these apply another bandage; the plaster sets rapidly, and the patient may soon be taken from the apparatus and laid upon a hair mattrass; the pad must be removed from the abdomen and the bandage pressed firmly about anterior superior spines and from the breasts when used, and compression made against the sternum to fix the part firmly; if the bandage is weak at any point wet the part and dust it with plaster (Fig. 134). The abdominal pad may be dispensed with, and firm support given by the bandage to the lower part of the region, if an opening is cut in the dressing, corresponding with the stomach, after the bandage is firm (Fig. 135).[1] Additional fenestræ are often required as at the curvature, or where sinuses are discharging.

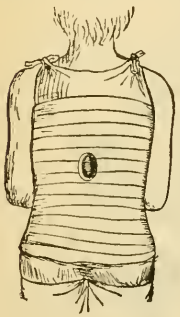


Fig. 134.

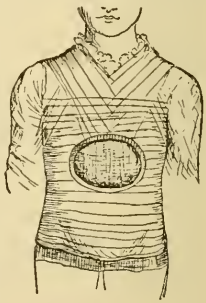


Fig. 135.

The compensative curves of the spine may be more completely straightened by inducing profound anæsthesia before suspension, and experience proves that there is no danger during anæsthesia, either in the position of the patient or in the compression of the thorax by the gypsum, even if the patient remains suspended, as is usual, until the dressing becomes firm.[2]

If the diseased vertebræ are in the lumbar or lower dorsal regions the bandage need not be applied higher than the axillæ, but if the caries exist in the upper dorsal region there must be additional support of the upper part of the thorax, and this is obtained by continuing the bandage over the shoulders, and thus encasing the entire

[1] Bellevue Hosp. Records. [2] Von Langenbeck.

trunk in the common dressing (Fig. 135). When this form is used the arms must not be in the sling but should hang by the side. By this means the spine can be permanently maintained erect. When the caries attacks the cervicals, means must be used to so support the head that the contiguous vertebræ may not be compressed. This may be accomplished by supporting the chin, or by lifting the head entire. The chin may be sustained by extending the plaster of Paris jacket (Fig. 135) upwards as a cravat, well lined with cotton batting, or other soft material (Fig. 136). Or, the head may be raised entirely from the column by an appliance (Fig. 137) so incorporated in the plaster bandage that it has a firm basis of support, and by a sling which accurately fits the chin and occiput and lifts the head directly upwards (Fig. 137).

Fig. 136.

To apply the apparatus the patient is suspended in the usual way, from the axillæ, chin, and occiput, and the plaster bandage applied, as usual, over a tight-fitting knit or woven shirt. After the bandage has been accurately applied, the patient is removed from the suspending apparatus and carefully laid upon an air bed until the plaster has hardened or "set." The patient can then stand up, and the apparatus for suspending the head is applied in its proper position, over the back of the plaster jacket, and the lower portion of it bent and moulded until it accurately fits all its various curves. The loose tin strips, being very flexible, can then be smoothly moulded around the jacket which has already been applied to the trunk, and another plaster bandage, having been wetted in water, is to be carefully and tightly applied over the apparatus and jacket first applied, in sufficient number of layers to make it perfectly secure. The tin being rough and perforated, a sufficient amount of plaster will be incorporated into its holes and meshes to prevent any possibility of displacement. We have now a secure point of support from the pelvis and trunk, and the head can be sustained by properly adjusting the movable rod and securing it by screws.

Fig. 137.

The gypsum dressing may be worn without change from two weeks to two months, according to the effect which it produces; when renewed, the patient should be thoroughly washed, but without assuming the upright position. The final cure is rarely completed in the most successful cases in one year.

There are several kinds of useful apparatus for spinal caries more or less complicated in their mechanism, and requiring great experience and care in their successful management.

A very neat and efficient spring corset[1] may be so constructed and applied as to protect the diseased vertebræ from injury, and allow great freedom of motion of the trunk; the springs are brass, of a serpentine form, especially tempered, elastic and, by a little manipulation, readily adapted to any surface, however irregular or uneven, to which they are applied; in their spring-like action exists an elevating power, an auxiliary to the local and general support rendered, the tendency of which is to take off the superincumbent weight of the body from the diseased vertebræ.

A spinal brace[2] may be so applied as to take the weight of the trunk above the point of disease from the bodies of the vertebræ and throw it on the articular processes. There are two pieces or levers passing up the back, not over the spine, but each side of it, so that it is firmly held from lateral deviations; to the upper end of these, two curved pieces of steel are fastened diagonally on both sides of the neck; they pass directly forward and around the shoulder, and thus prevent a great loss of force by diagonal action. This arrangement entirely obviates the painful and injurious ligaturing of the arms, which would occur if the straps passed forward from one point. At the part opposite the point of disease, the point where the fulcrum pads are placed is made of chamois skin or Canton flannel, filled with cork filings, which have no felting qualities, or, if desirable, can also be made of hard rubber; the shoulder-straps and the band around the hips are likewise provided with similar pads to protect the skin from pressure and abrasion; the instrument, like the spine itself, acts like a double lever with a common fulcrum at the curvature; this action is directly backward at the hips and shoulders and directly forward at the middle of the back, or wherever the diseased part is located; thus the posterior portion, the only healthy portion of the diseased vertebræ, is made to support a part of the weight of the body and the intervertebral cartilage and bodies of the vertebræ, where the disease exists, are relieved of pressure. The abdomen is still further sustained in the upward direction by an apron in front which is fastened on each corner. If the disease is in the upper dorsal or cervical region, an apparatus is constructed for such cases with an attachment for sustaining the head; the effect and form of this attachment is that of a lever, acting backwards to raise the head and neck.

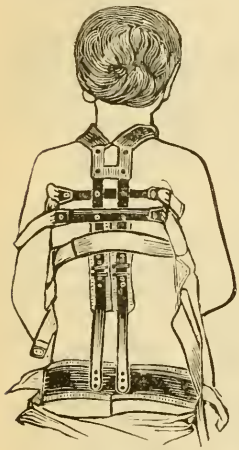


FIG. 138.

3. Spinal abscesses,[3] whether they appear in the lumbar region or below Poupart's ligament, should be opened antiseptically, as follows: While the spray covers the region of incision, make a sufficiently free opening at the most dependent part to allow of the complete escape of the contents; after the pus has ceased to flow inject carbolic solution thoroughly into all parts until the fluid returns clear; with the last injection cause hyperdistention of the cavity by holding the edges of the wound firmly to the nozzle while the fluid is

[1] J. A. Wood. [2] C. F. Taylor. [3] J. Lister.

injected; if the deep sinus can be found pass a tube, as a catheter, as far as practicable without injuring the parts, and throw the injection as nearly as possible up to the carious vertebræ; insert two or three drainage tubes, rubber tubes with holes cut in at different points

Fig. 139.

(Fig. 139), and cover with the gauze or carbolized dressings; change these dressings under spray as often as the discharges require, washing the cavity out with carbolic solutions whenever there is any indication of putrid matters present; continue these dressings until the abscess has closed or is reduced to the condition of a sinus. Treated in this manner, spinal or other congestive abscesses may be freely opened, their contents removed, and a healthy granulating surface established and the sinus often closed without incurring the ordinary risks of profuse suppuration and systemic poisoning.

If antiseptics are not employed, the following advice cannot be too carefully heeded: If the abscess comes from a bone on which an operation is impossible or undesirable, do not meddle with it, but be thankful for every day that it remains closed, and wait quietly until it opens, for thus there will be relatively the least danger.[1]

III. LOOSE BODIES.

These bodies in the knee-joint are outgrowths of cartilages in chronic rheumatic arthritis, or in the dendritic growth of synovial fringes accidentally detached, or portions of the proper articular cartilage with or without some subjacent bone which has been exfoliated into the joint.[2] The symptoms are slight pain in knee with weakness, and often moderate dropsy, and at length sudden pain and inability to walk while the knee stands between flexion and extension, due to the loose body being caught between the bones forming the joint, or the semilunar cartilages, or in one of the synovial sacs; it may at times be detected and fixed by external manipulation.[1] When very troublesome, it must be removed by the antiseptic method under the spray; fix the body as firmly as possible and make a free incision upon it; apply the antiseptic dressing and secure perfect rest; if there is much effusion, drainage tubes should be introduced.[3] If antiseptics are not used, the utmost care must be taken to protect the joint from the entrance of air; force the body tightly under the skin at one side of the joint, press the skin strongly upward, and put it still more on the stretch, then cut through the skin and capsule down upon the body, and let the latter spring out, or lift it out

[1] T. Billroth. [2] Sir J. Paget. [3] J. Lister.

with an elevator; instantly close the wound with the finger, extend the leg, let the skin return to its normal position so that the cut in it lies lower than in the capsule, and the two wounds do not communicate directly; close the skin wound with sutures and plasters; extend the limb on a splint, or apply the gypsum dressing before the operation, and make a large opening over the joint.[1] The subcutaneous incision may be made, and the body forced into the connective tissue, where it is allowed to remain or is subsequently removed.

CHAPTER XVII.

GENERAL OPERATIONS ON THE JOINTS.

1. EXCISION.

The excision of a joint is the more or less complete removal of the articular surfaces of the bones which enter into its formation.

1. **The indications** for the necessity of excision are: for shot injuries, the comminution of the joint ends of the bones, or the impaction of a ball in the end of the bone in such manner that it cannot be removed without destruction of the bone; in compound dislocation with extensive injury of the soft parts, or complicated with fracture; in caries which has destroyed the articular surface, and continues to progress in spite of well-directed efforts to control it.

2. **The time** of excision should be immediate in all injuries which undoubtedly necessitate its performance, but for caries it should be delayed until the appropriate measures for its arrest have been thoroughly applied without success.

3. **The method** of operation should aim (1.) to remove all diseased structures without needlessly sacrificing parts; in children, especially, the epiphyses of bones must be preserved with the most scrupulous care, to insure their future growth; in adults the amount of bone removed will always have regard to the future usefulness of the joint; (2.) to preserve the functions of the joint; the fibrous structures which strengthen must be saved in their proper relations; the periosteum must be preserved with the attachments to the capsule; the muscular attachments must be separated uninjured, or with the bony fragments of their insertions to insure their future usefulness; the bones must be so shaped and placed in position as to maintain their special movements, preserving even a useful hinge-joint at the elbow [2] and at the knee.[3]

[1] T. Billroth. [2] H. J. Bigelow. [3] C. Hüter.

JOINTS OF THE UPPER LIMBS.

1. **The phalangeal joints** should be excised by an incision along the side, slightly convex downwards; through a single incision the extremities of the bones may often be reached and excised by turning them outwards. In the treatment make sufficient extension by means of a palmar splint to keep the bones apart, and begin passive flexion as soon as repair is established.

2. **The metacarpo-phalangeal joints** should be excised by dorsal incisions along the margin of the extensor tendons, which must be drawn one side; the articular surfaces being cleared, excise them with cutting forceps, a fine saw, or chain saw. The treatment is the same as after excision of the phalangeal joints.

3. **The wrist joint** is properly limited to the articular end of the radius, and the first row of carpals. But excision at the wrist includes the removal, not only of the radius and first row of carpal bones, but of a part or whole of the ends of the radius and ulna, a part or whole of the carpus, the proximal ends of the metacarpal bones, or all of these at once.[1]

The radio-carpal articulation is formed between the radius and triangular fibro-cartilage above, and the scaphoid, semilunar, and cuneiform bones below; the carpal articulations are arthrodial; the synovial sacs are so arranged that their communications are limited; this anatomical peculiarity should be remembered in the effort to remove portions of the carpus, as it is desirable not to open these cavities farther than is absolutely necessary; the ligaments are dorsal, palmar, and interosseous.

In the radio-carpal and common carpal articulation, there is allowed not only flexion and extension, but a certain amount of lateral bending.[2]

The per cent. of mortality of all exsections at the wrist is, for disease, 7; and for shot injuries, 15: the per cent. of usefulness of the wrist in the cases which have given determined results is, for disease, 7 perfect, 45 useful, and 24 worthless; for injuries, 28 perfect, and 57 useful; for shot injuries, 1 perfect, 28 useful, and 17.5 worthless, or requiring amputation; the effect of the extent of excision upon the per cent. of usefulness is, for partial 62.9, and for complete 83.[3] The following are the definite end results after various excisions for shot injuries at the wrist;[4] in five complete excisions the functions of the hand were much impaired, but preferable to amputation; in four excisions of the extremities of radius and ulna, there was lateral distortion of hand and stiffness of fingers; in twenty-one excisions of the lower end of the radius nearly all had anchylosis and extreme deformity; the hand generally being strongly deflected to the radial side, often at right angles, the fingers rigidly fixed in flexion or extension, the end of the ulna projecting, and the integument over it irritated and exposed to accidental injuries; in fourteen excisions of the ulna, nearly all had anchylosis and deformity, the hand was generally less displaced, but there was an equal

[1] R. M. Hodges. [2] Quain's Anat. [3] H. Culbertson. [4] G. A. Otis.

proportion of cases of ridigity of the fingers, and more examples comparatively of paralysis and of neuralgic suffering; in six cases of excision of the end of the radius with one or more carpals, there was anchylosis and deformity; in eight cases of excisions of the end of the ulna with adjacent carpals, or carpals and metacarpals, two had very useful hands, but the remainder had anchylosis, contracted fingers, and other deformities: in eight excisions confined to the carpus, three retained valuable mobility of the hand, and five had anchylosis with much deformity; from this record it seems probable that recovery unattended by anchylosis is seldom to be anticipated, yet that this result is not disastrous provided the hand is in good position, and the functions of the fingers are in some degree preserved. But these imperfect extremities are far more useful, especially when supported by suitable apparatus, than stumps after amputation.[1]

Excision for caries has hitherto been unsuccessful chiefly owing to the recurrence of the disease, and the impaired functions of the hand; but these results are largely due to partial excisions, and hence the necessity of complete removal of the wrist when affected with caries. Even bones which appear sound in a carious joint seem apt to be affected in an insidious, incipient degree, and if left behind may lead to recurrence of the complaint.[2]

The indications for excision are; for shot injuries, if there is comminution of the bones of the carpus, or of the carpus and epiphyses of the bones of the fore-arm, especially if the missile is lodged, and cannot be removed otherwise; if subsequently infiltration cannot be controlled by incision and threatens to spread to the fore-arm;[3] in injuries, as compound dislocations, all displaced and fractured bones which must eventually become detached should be at once removed; in crushing injuries when vessels, nerves, and soft parts are not so much involved as to render amputation necessary; in secondary excisions for injuries to the carpus the entire wrist should be removed; in caries involving the carpus extensively, and which has resisted other treatment, excision becomes necessary.

Excision of the entire wrist consists of a series of operations each of which must be executed with scrupulous care, as follows:[2] Break down adhesions of tendons by freely moving all the articulations of the hand; commence the first incision at the middle of the dorsal aspect of the radius, 2 (Fig. 140), on a level with the styloid process; carry it towards the inner side of the metacarpo-phalangeal articulation of the thumb, running parallel in this course to the extensor secundi internodii; on reaching the line of the radial border of the second metacarpal bone, carry it downwards longitudinally half the length of the bone, the radial artery lying farther to the outer side of the limb; detach the soft parts from the bone at the radial side of the incision, the knife being guided by the thumb nail; divide the tendon of the extensor carpi radialis longior at its insertion into the base of the second metacarpal bone, and raise it along with that of the extensor carpi radialis brevior previously cut across, and the ex-

[1] E. D. Hudson. [2] J. Lister. [3] Von Langenbeck.

tensor secundi internodii while the radial is thrust somewhat outwards; separate the trapezium from the rest of the carpus by cutting forceps applied in the line with the longitudinal part of the incision; leaving the trapezium in position until the rest of the carpus is taken away, dissect the soft parts on the ulnar side of the incision from the carpus as far as convenient, the hand being bent back to relax the extensor tendons of the fingers; commence the second incision, 3 (Fig. 140), at least two inches above the end of the ulna, immediately anterior to the bone, and carry it downwards between the bone and flexor carpi ulnaris, and on in a straight line as far as the middle of the fifth metacarpal bone on its palmar aspect; raise the dorsal lip, cut the extensor carpi ulnaris at its insertion into the fifth metacarpal bone, and dissect it from its groove in the ulna without isolating it from the integuments; separate the extensors of the fingers from the carpus, and divide the dorsal and internal lateral ligaments of the wrist-joint; leave the connections of the tendons with the radius undisturbed; now clear the anterior surface of the ulna by cutting towards the bone, avoiding the artery and nerve; open the articulation of the pisiform bone, and separate the flexor tendons from the carpus, the hand being depressed to relax them; clip through the base of the process of the uneiform bone with pliers, but avoid carrying the knife farther down the hand than the bases of the metacarpal bones; divide the anterior ligament of the wrist-joint, separate the carpus from the metacarpus with cutting pliers, and extract the carpus with sequestrum forceps through the ulnar incision, dividing any ligamentous attachments; the articular ends of the radius and ulna may be protruded at the ulnar incision and excised; divide the ulna obliquely with a small saw so as to take away the cartilage-covered rounded part over which the radius sweeps while the base of the styloid process is retained; clear the radius sufficiently to remove the articular surface; if the caries is slight remove a thin slice without disturbing

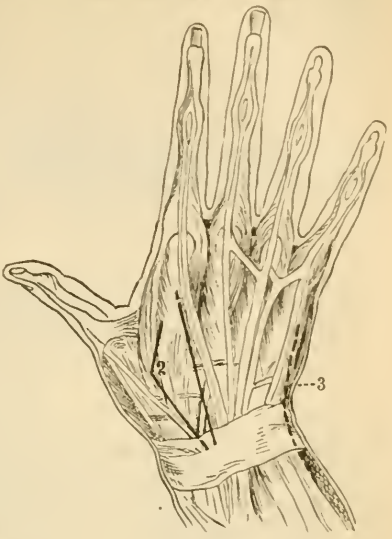


FIG. 140.

the tendons in their grooves on the back of the bone; clip away the articular facet of the ulna with bone forceps applied longitudinally; if the caries is extensive remove freely all the diseased bone with pliers and gouge; examine the metacarpal bones and excise the articular surfaces only if they are sound, and more extensively if diseased; next seize the trapezium with strong forceps, and dissect it out without cutting the tendon of the flexor carpi radialis, and excise the end of the metacarpal bone; clip off the articular facet of the pisiform bone, and, if sound, leave the remainder in position; close the radial incision firmly throughout with sutures, and also the ends of the ulnar incision; but the middle must be kept open by pieces of lint introduced lightly to give support to the extensor tendons, and afford free escape of pus.

The incision [1] may be made from the middle of the ulnar border of the metacarpal bone of the index finger upwards to the middle of the dorsal surface of the epiphyses of the radius, 1 (Fig. 141), crossing to the ulnar side of the extensor carpi ulnaris at its insertion into the base of the third metacarpal bone, and dividing the dorsal ligament of the carpus between the tendons of the long extensor of the thumb, and the extensor indicis; the soft parts being raised through this incision by careful manipulation of the hand, the carpal bones may be removed one by one by dividing the ligaments which bind them together and to other bones.

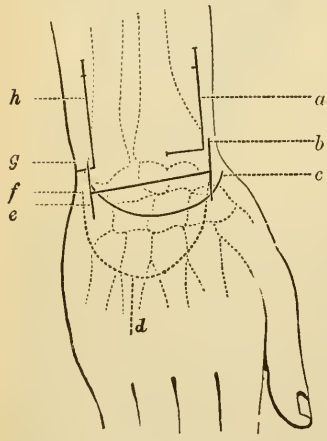


FIG. 141.

Various other methods of partial and complete excision have been devised (Fig. 141). A common method has been by parallel incisions, one on the radial, *b*, and the other on the ulnar border, *e*, joined by a transverse incision on the dorsum of the carpus.[2] The great defect in this method, as in similar incisions, variously curved, *c* and *f*, is that the extensor tendons are sacrificed; though these incisions may be adopted in exceptional cases, they do not offer the advantages of the method [3] given.

The after treatment [3] must be pursued with due recognition of the fact that the new joint at the wrist is produced by an approximation of the bones of the fore-arm and of the metacarpus, partly by shortening of the limb and partly by the growth of new bone from the divided ends; with proper care, perfect symmetry of the hand can always be insured; for as the radius and ulna above, and the meta-

[1] Von Langenbeck. [2] Sir W. Fergusson. [3] J. Lister.

carpus below, are divided in parallel lines, the shrinking of the new material between them draws the hand equally upwards towards the forearm; the surgeon should aim to maintain flexibility of the fingers by frequently moving them, and at the same time to procure firmness of the wrist by keeping it securely fixed during the process of consolidation. These indications are met by placing the limb on the splint (Fig. 142),[1] which consists of an obtuse-angled piece of thick cork attached to a splint, with a cross-bar of cork attached to the under surface about the level of the knuckles; on the splint the hand lies semi-flexed, its natural position, the fingers midway between the extremes of flexion and extension into which it is necessary to bring them in the daily passive movements; the thumb is to be kept from the index-finger by a pad of cotton maintained between them; flexion and extension of the fingers should be commenced on the second day, whether inflammation has subsided or not, and continued daily, each finger being flexed and extended to the fullest degree possible in health, care being taken that the metacarpal bone concerned is held steady; pronation and supination must not be neglected, and as the wrist acquires firmness, flexion and extension, adduction and abduction, should be occasionally encouraged; passive motion must be continued until there is no longer a tendency to contract adhesions.[1]

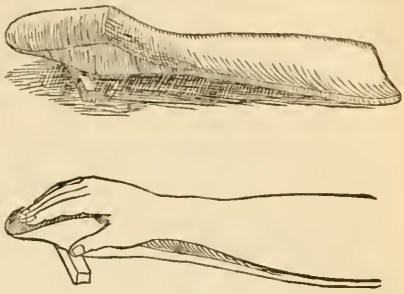


Fig. 142.

2. **The elbow-joint** has two motions, flexion and extension, which are limited to the locking of the coronoid and olecranon processes in the respective fossæ of the humerus which receive them; the path of motion is in nearly a vertical plane with a direction slightly outwards; the inner lip of the trochlea being prominent below, forms an expansion which corresponds to an inward projection of the coronoid part of the ulnar surface, and is only brought into use in flexion; the outer lip of the trochlea being everted at the upper and back part, forms a surface which is only in use in complete extension, and which then corresponds to a surface on the outer aspect of the olecranon, which comes in contact with no other part of the humerus; in flexion and extension, the radius moves by its cup-

[1] J. Lister.

shaped head upon the capitulum, and on the groove between that process and the trochlea by a ridge internal to the cup.[1]

The per cent. of mortality from excision for shot injuries is 19, for injuries 15, for disease 10; for deformity, no deaths in 13 cases; for all classes, 15.69 per cent. in 1.075 cases.[2] The results of other treatment may be thus stated: for shot injuries the expectant plan gives deaths 10.3 per cent.; amputation in the arm, 24.3 per cent.;[3] for injuries, amputation of the arm gives 34 per cent.;[4] and for disease, 26 per cent. mortality.[5] Complete excision is more favorable to life than partial, in shot injuries and disease, the per cent. of mortality of the former being, for shot injuries, 25; for diseases, 9; the latter, for shot injuries, 26.7; for diseases, 11; for injuries proper, entire excision is more fatal than partial, the mortality being, for the former, 21 per cent., and for the latter 7.4 per cent.; of the vigorous 33, of the exhausted 66 per cent. die after excision; the most favorable age is, for shot injuries, 20–25; for injuries, 30–40; for disease, 10–20; the most favorable period is, for injuries, the primary, and for disease, between 9–12 months from the origin.[2]

The usefulness of the joint after excision depends upon the perfection of the hinge, or antero-posterior motion. The extreme conditions in which it may be left are anchylosis, and a flail-like, or dangle-joint action. Though in both cases the limb is often very useful, yet every effort should be made to avoid such results. While it is true that after-treatment has much to do with the prevention of anchylosis, yet, in general, the extent of exsection determines the degree of mobility, and also the power of controlling it; if too little is taken away there will be more or less complete anchylosis, and if too much, there will be such relaxation of the muscles as to prevent their efficient action; excisions which have given the best results have been at the commencement of the condyloid projections of the humerus, and at the base of the coronoid process of the ulna.[6] The periosteum should be carefully preserved, whatever method is adopted. It may be established as a rule, that excision for injury should be partial and conservative, and for disease it should be entire, or limited only by the removal of the diseased bone.[6]

When the disease or injury is limited, it is of doubtful propriety to inflict additional injury by section of healthy bone, for excellent results have been obtained when the joint ends of either the upper or fore-arm have been removed after complete exposure of the joint, and the uninjured portions of the articulation have been unmolested.[3]

The method of operation may be by an incision made longitudinally, or by the H,[7] the T,[8] the ⊢, the ⊣, the + shaped. The results, both as to mortality and usefulness, prove that absolute preference should not be given to either method in all cases, but that the incision should be selected on anatomical grounds, or in relation to

[1] Quain's Anatomy. [2] H. Culbertson. [3] G. A. Otis. [4] S. D. Gross. [5] J. E. Erichsen. [6] C. Hütér; Von Langenbeck. [7] Moreau. [8] J. Roux.

convenience, or facility of execution.[1] In general, the longitudinal incision, by giving sufficient exposure of the joint, and enabling the operator to avoid easily the transverse division of muscular attachments, ligaments, and fibrous structures, should be preferred.[2] Subperiosteal exsection is as follows: Make an incision, 2, 2 (Fig. 143),[3] two or three inches long on the posterior surface of the joint, a little internal to the middle of the olecranon, beginning about an inch above the tip of the olecranon, and extending an inch and a half or two inches above that point, upon the border of the ulna, and through muscle, tendon, and periosteum to the bone; with the elevator, raise the periosteum of the ulna towards the inner side, and detach the inner half of the tendon of the triceps in connection with the periosteum, by means of short, parallel, longitudinal incisions; with the left thumb nail, draw the soft parts which cover the internal condyle and enclose the ulnar nerve towards the epicondyle, and detach them by means of curved incisions until the epicondyle is entirely uncovered; the last incisions separate the origins of the flexor muscles and the internal lateral ligament, their connections with the periosteum being retained; now draw the outer portion of the triceps tendon outwards and separate by short incisions from the olecranon, maintaining, however, its connections with the periosteum of the outer side of the ulna, which is raised from the bone with the insertions of the anconeus; by repeated incisions along the bone, loosen the fibrous capsule of the joint from the margin of the humerus, first over the trochlea, until the internal condyle appears; detach the external lateral ligament and origins of the extensor muscles, so that all remain in connection with each other and the periosteum; now forcibly flex the arm, protrude the articular surfaces through the wound, and saw them off; if the ulna is sawn off below the coronoid process, separate the upper fasciculi of the brachialis anticus without disturbing the union of the tendon with the periosteum.

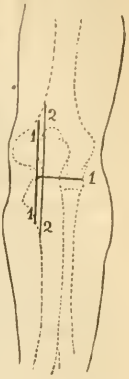


FIG. 143.

Subperiosteal resection may be so performed as to retain the origins of muscles, as follows:[4] Make parallel incisions over the external and internal condyles, of proper length; raise the soft parts from the internal condyle, separate the attachments of the flexors with the lamellæ of bone, by means of the chisel; raise the periosteum on both surfaces with the elevator, and divide the lateral ligament; repeat the same operation on the external condyle; now divide the humerus above the condyles, separate the attachments of the triceps with periosteum and lamellæ of bone; detach the coronoid process from the ulna; divide the extremity of the ulna and remove it.

[1] H. Culbertson. [2] Von Langenbeck; R. M. Hodges. [3] Von Langenbeck. [4] Voigt.

The ⊢ incision 1, 1, 1 (Fig. 143) may sometimes be preferred; the arm being semiflexed, make an incision three or four inches long on the inner aspect of the dorsal surface of the joint, commencing about two inches above the internal condyle, and external to the ulnar nerve, which must be carefully drawn inside when exposed; make a second incision at right angles, dissect up the two flaps to the requisite extent; remove the olecranon with strong cutting forceps and expose the interior of the joint; divide the lateral ligaments; detach the periosteum from the surface of the humerus; pass the handle of a scalpel under the bone, and saw upon it; turn back the fragment cut off, and detach it from the joint; separate the head of the radius from the neighboring soft parts, pass a compress under it, and cut it off, preserving all or part of the attachment of the biceps; then lay bare the ulna, prolonging downwards the internal incision; if necessary, isolate the portion to be cut off from the periosteum; put it aside from the soft parts with a compress or protecting guard, and saw it, preserving, if possible, the attachment of the brachialis anticus.

If the condyles are not diseased the hinge motion may be preserved by operating as follows:[1] After the median incision is made and the ulna cleaned, saw partly through this bone about an inch and a half from the olecranon, and complete the section with forceps; now dislocate the humerus backward and saw obliquely into the olecranon depression, first from the bed of the ulnar nerve, which is drawn to one side, and similarly from the external condyle; break out the included mass; (Fig. 144) divide the orbicular and lateral ligaments, dislocate the forearm backward, and saw off the radial extremity. The limb must be placed in a trough splint, semiflexed at the elbow, made of wire or tin, having a large fenestrum cut out at the joint to admit of easy access to the wound. The gypsum dressings may be applied with steel or iron bands curved at the joint so as to leave the wound perfectly free, and fastened above and below in the gypsum. Complete drainage must be secured by position or drain tubes, and freedom from all sources of irritation. As the cure progresses, passive motion must be early begun and persevered in until the cure is complete.

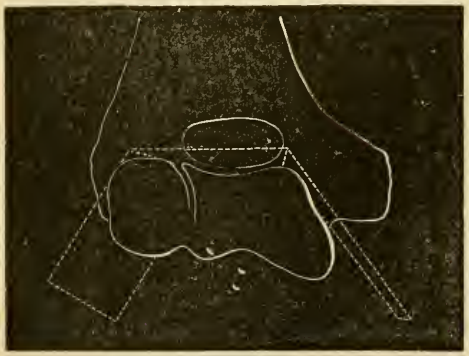


Fig. 144.

3. **The shoulder joint** consists of the large and hemispherical head of the humerus, opposed to the much smaller surface of the

[1] H. J. Bigelow.

glenoid cavity of the scapula; the bones are not retained in position by the direct tension of strong ligaments, which would have too much restricted the movements, but by surrounding muscles and atmospheric pressure; the ligaments are the capsular, which invests the joint, the coraco-humeral, a broad bundle of fibres extending over the upper and outer part and attached to the root of the coracoid process, and the glenoid, which surrounds and deepens the articulation; the function of the joint is to give support to the arm and great freedom of movement, which is restricted only superiorly and posteriorly by the margin of the acromion.[1]

The general mortality from excision is 29.84 per cent, distributed according to the causes as follows: shot injuries, 34; injuries, 27; disease, 18.[2] The mortality of shot injuries, according to the methods of treatment pursued is: expectant, 25 per cent; excision, 36; amputation, 29 per cent.[3] Various circumstances influence the mortality, namely, the vigorous give 10, and the exhausted 27 per cent. of deaths; complete excisions are less fatal than partial; those involving a portion of the head of the humerus are not so fatal as those involving the entire head; excision of the head and limited portions of the scapula is less fatal than removal of the entire head; the mortality is no greater in the removal of more or less of the upper fourth of the humerus than of the head alone, and is even less when the upper fourth is removed with a portion of the scapula, though the mortality increases when the upper half of the humerus is removed; yet it is diminished to that of excision of portions of the head, when a part of the scapula is also excised; when more than half of the humerus is excised the mortality is still more diminished.[2] The usefulness of the limb after excision is given as follows: After excision for disease, 9.4 per cent. had perfect results, and 70.5 per cent. useful limbs; for injuries, 12.5 per cent. had perfect results, and 62.5 useful limbs; for shot injuries, 2.7 per cent. had perfect results, and 22.2 per cent. useful limbs.[2] The amount of motion is generally very satisfactory, but is not greater than that after recovery with anchylosis; the arm cannot be elevated beyond the horizontal line, and in many cases hangs down without any power in the deltoid; but the movements of flexion, extension, and adduction are generally free, and there is usually sufficient power in the forearm to carry heavy weights and perform many of the ordinary domestic tasks; recovery with anchylosis, therefore, gives as favorable results as regards the usefulness of the limb as the most successful excision.[4]

The indications for excision are: In caries, when a cure by natural processes has failed to follow judicious treatment, either from the extent of the disease in the bone, or the general feebleness of the patient's powers;[5] in compound dislocation;[6] in compound fracture with protrusion of the shaft through the wounds, and rupture of the capsule with destruction of the periosteum;[7] in extensive shot injuries, as the impaction of a ball in the head of the humerus, or comminution of the epiphysis.[8] The method of operation has little or no influence upon the mortality, but it has a marked relation to the

[1] Quain's Anatomy. [2] H. Culbertson. [3] G. A. Otis. [4] T. Holmes.
[5] T. Bryant. [6] F. H. Hamilton. [7] E. Chassaignac.
[8] G. A. Otis; Von Langenbeck.

usefulness of the limb, *e. g.*, the longitudinal incision gives 8 per cent. perfect, and 45.6 per cent. useful limbs; the various other incisions give but a fraction over 1 per cent. perfect, and at the highest 11 per cent. useful limbs.[1] The straight incision should, therefore, be preferred in ordinary excisions. Subperiosteal excision of the humerus should, as far as possible, be practiced in order to secure greater length of limb, for while the degree of shortening ordinarily bears a certain relation to the extent of bone excised, in subperiosteal exsections this law does not hold good, the shortening being comparatively vastly less in the latter, *e. g.*, 3.93 inches removed with periosteum gave 3 inches shortening, while 4 inches removed, subperiosteal, gave only one-half an inch shortening.[1]

Exsection may be performed by the methods given (pp. 127, 128), or as follows:[2] The patient lying on the back, the shoulder raised on a cushion, and the external condyle looking forward, make an incision commencing at the border of the acromion near the clavicular articulation, and carry it directly downwards through the deltoid muscle to the capsule and periosteum (Fig. 145); draw aside the margins of the wound with retractors, and recognize the tendon of the long head of the biceps; run the point of the knife along the outside of the tendon, opening the groove and capsule to the acromion; draw the tendon one side, and while the arm is rotated outward, with a circular sweep of the knife, held perpendicularly to the bone, divide the capsule and the attachment of the subscapularis to the lesser tuberosity; then rotate the arm inwards, and in the same manner sever the capsule and the insertions of the supra and infra spinatus and teres minor from the greater tuberosity; the head of the bone is now thrust out of the wound and removed by a narrow back saw passed behind it. Any portion of the glenoid cavity may be exsected through this wound. If larger space is required, as in necrosis of the acromion, make additional incisions (Fig. 146).

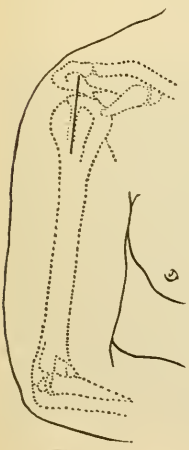


FIG. 145.

FIG. 146.

[1] H. Culbertson.

[2] Von Langenbeck.

Subperiosteal resection may be effected by this method as follows:[1] divide the periosteum along the incision and raise it from the bone, first on the inside while the arm is rotated outwards, detaching with it the insertions of the subscapularis; then on the outside, while the arm is rotated inwards, separating the insertions of the external rotators; this part of the operation is difficult in primary resection owing to the thinness of the periosteum; the head of the bone being now exposed it may be turned out and excised.

The treatment consists in fixing the arm upon the triangular cushion[2] and inserting a suitable drainage-tube; in primary exsection the tube may pass out at an opening made posteriorly, the wound being firmly closed by sutures.[1]

JOINTS OF THE LOWER LIMBS.

1. **The phalangeal joints** should be exsected by incisions on the side of the joint, convex downwards. The treatment is the same as the similar operation in the upper limb.

2. **The metacarpo-phalangeal joints** should be excised by dorsal incisions along the extensor tendons, which must be preserved and drawn aside; the treatment is extension and passive flexion. The metatarso-phalangeal joint of the great toe may be removed by a lateral semi-lunar incision over the joint.

3. **The metacarpo-tarsal joints** have been exsected with good results thus,[3] make a semilunar incision on the dorsum of the foot and dissect the flap upwards; expose the first row of tarsal bones and exsect their surfaces with a saw; now expose the articular surfaces of the metacarpal bones and excise them.

4. **The tarsal joints** generally become carious in connection with such extensive caries of the tarsal bones as necessitates the extirpation of entire bones. Single joints may, however, be excised when the disease is limited, as the astragalo-scaphoid, the calcaneo-scaphoid, the calcaneo-astragaloid. The incision should be made over the affected joint and curved, and the articular surfaces should be removed with a fine saw or gouge.

5. **The ankle joint** is a hinge joint: the inferior extremities of the tibia and fibula united form a kind of arch which embraces transversely the superior articular surface of the astragalus so as to render lateral movements impossible when the ligaments are tense.[4]

The mortality[5] in the total excisions at the ankle-joint is 12.9 per cent., and for each class as follows: for disease, 8.5 per cent.; for injuries, 12.5 per cent.; for shot injuries, 12.6 per cent.; between the ages of 1 and 15 there were no deaths; the mortality was greatest in the following order of age periods, 20-25, 15-20, 25-20, 30-40, 50-60, and greatest from 40-50 years. In excision for disease the largest number of deaths are found at the period 30-40, and in excision for injuries the least number; the cause of death attributable to the operation is

[1] Von Langenbeck. [2] Fig. 68. [3] T. Holmes. [4] Quain's Anatomy. [5] H. Culbertson.

9.7 per cent., and to the disease or injury, or other diseases, 58.8 per cent.; the mortality increased in proportion to the extent of bone excised as follows: excision of the tibia gave 4.7 per cent.; of the fibula 8.6 per cent.; of the astragalus, 13 per cent.; of the tibia and fibula 18.4 per cent.; of the tibia, fibula, and astragalus, 24.4 per cent.; no deaths occurred when excision for disease and injuries was not practiced until after eight months from the attack, from which it is inferred that other joints gradually became involved, rendering the operation more and more dangerous by delay.

The usefulness of the limb was recorded as follows: in excision for disease, 5 5 per cent. were perfect, 60.1 per cent. useful, and in 12 per cent. the extremities were amputated; for injuries, 6 per cent. were perfect, and 59.3 per cent. were useful, for shot injuries 6 per cent. were perfect, 42 per cent useful, and 6 per cent. were amputated, from which it is concluded that a large proportion of these excisions result in more or less usefulness of the limbs.

The indications for the operation are as follows: (*a.*) In compound fractures and dislocations of the ankle-joint, with large, lacerated wounds, and protrusion of the bones, immediate excision greatly increases the chances of saving life and limb;[1] (*b.*) in neglected compound fractures at the joint, originally produced by severe destruction, combined with extensive laceration of the ligaments, attended with suppuration, formation of fistulæ, partial dislocation, excision is the only remedy to produce rapid healing, and to gain a useful limb;[1] (*c.*) in acute suppuration, due to osteo-myelitis, with abundant fetid discharge, and destruction of ligaments; (*d.*) in cases which have recovered with so much deformity that the foot cannot be made useful with mechanical appliances;[1] (*e.*) in chronic caries limited to the articulation of the tibia, fibula, and astragalus.[2] The indications against the operations are: (*a.*) marked constitutional cachexia;[3] (*b.*) chronic caries of the ankle-joint, especially in children, which is curable by drainage, removal of carious portions of bone with the gouge, and immobile apparatus,[4] and in persons advanced in years, in whom amputation at the ankle-joint is more speedy and safe;[1] (*c.*) extension of the caries to the ankle-joints and bones, or upward along the shaft of the tibia.[3]

The operation which best preserves vessels, nerves, and tendons, as well as the periosteum, is by two longitudinal incisions, one over the external and the other over the internal malleolus, and extended above and below sufficiently to give free access to all of the diseased bone.[5] All transverse incisions involving the vessels, nerves, and tendons should be avoided.[6]

Excise as follows:[5] The limb being turned on the inner side upon a firm pillow, make an incision two or three inches long on the middle of the fibula down to the point of the malleolus, and sufficiently deep to divide the periosteum; from the extremity of the malleolus con-

[1] R. Volkman. [2] L. Ollier. [3] T. Holmes. [4] L. A. Sayre.
[5] Von Langenbeck. [6] H. Hancock.

tinue the incision about a third of an inch, but merely through the skin, so as not to injure the tendons, but to permit of their being raised from behind the malleolus; at the point where the bone is to be divided, separate the periosteum with the raspatorium, and turn down as much as circumstances will permit; introduce the point of the index finger, or a spatula, into the interosseous space to protect the soft parts during the act of sawing; incline the saw slightly towards the joint, so that the part to be removed will be external at the point of division; seizing the upper extremity of the fragment with very strong forceps, separate its connections with the raspatorium and knife when necessary; now turn the foot upon the external surface, and make the same incision as upon the fibula; the periosteum is more easily separated than from the fibula; saw the tibia in place with a fine-bladed saw, when the parts are unyielding from chronic inflammatory infiltration; in recent injuries, and acute suppurations, it may be possible, after the periosteum has been separated and the ligaments incised, to gradually dislocate the foot outwards with the aid of the knife, and remove the tibia with the saw.[1] To gain more complete access in many cases, the incisions made along the centre of the malleoli may be extended laterally along the margins of the extremities of these bones, 3 (Fig. 148). Or, the

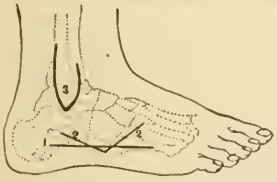


Fig. 147.

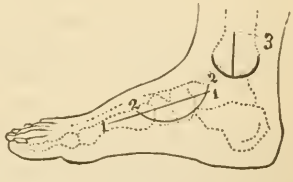


Fig. 148.

same result may be attained by extending the incisions made along the posterior margins of the tibia and fibula, around the lower and anterior margins of the malleoli, 3 (Fig. 147). Remove the carious parts of the astragalus with a gouge in chronic disease; resect only traumatic cases.

Modifications of the longitudinal incisions are as follows: Continue the external incision from the point of the malleolus downwards and forwards to within half an inch of the base of the outer metatarsal bone, making a flap; reflect this flap forward, expose and divide the fibula, and dissect out the fragment; now reverse the foot, and continue in like manner the internal longitudinal incision from the point of the malleolus to the projection of the inner cuneiform bone; reflect the flap, divide the internal lateral ligament close to the bone, and by twisting the foot outward the tibia and astragalus will appear at the wound; introduce a narrow-bladed saw between the tendons through to the external wound; saw off the end of the tibia and top of the astragalus.[2]

[1] R. Volkman. [2] H. Hancock.

A convenient method of suspending the limb is as follows:[1] Make a splint of wood or metal fitted to the anterior surface of the leg and ankle (Fig. 149), with rings inserted at three points for suspension: in its application, the splint is well padded and laid on the front part of the leg and the limb fixed by the ordinary bandage, the ankle being free (Fig. 150); or the gypsum bandage may be applied over the splint and around the leg, a layer of old flannel being first adapted to the leg, and the ankle left exposed.

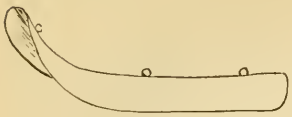


Fig. 149.

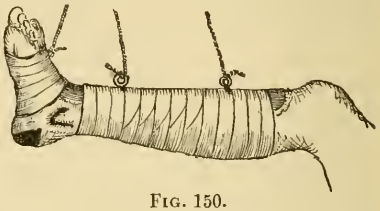


Fig. 150.

6. **The knee-joint** may be regarded as consisting of three articulations conjoined; namely, that between the patella and femur, and two others, one between each condyle of the femur and the tibia; the ligamentum mucosum is an indication of the original distinctness of the synovial membranes of the inner and outer joint; the crucial ligaments may be regarded as the external and internal lateral ligaments of those two joints respectively; each portion of the articular surface of the femur belongs either to one or other of the three component joints of the knee, and no part is common to any two of them.[2] The knee is a hinge-joint, having free motion in but two directions; it is supported principally by the lateral, the internal, and the posterior ligaments, and in front by the patella, and its ligamentous attachments; it has also a capsular ligament; the articular face of the tibia has a semilunar fibro-cartilage, which deepens the articular surface for the condyles of the femur.

The mortality[3] following excision is, for disease, in 603 cases, 29.8 per cent.; for injuries, in 28 cases, 39.2 per cent., and for shot injuries, in 61 cases, 75 per cent. The modifying conditions are as follows: the age most favorable for excision is for disease and injuries, 5–10; for shot injuries, 15–20; the period of the disease most favorable, is 3–6 months, and the most unfavorable 15–18 months, for shot and other injuries, secondary operations are most favorable; traumatic influences greatly increase the mortality in excisions for disease; complete excisions for disease give a higher per cent. of mortality (29) than partial (25), but for shot injuries it is the same (75); in general the mortality increases in proportion as less than $2\frac{3}{4}$ inches are removed; from $2\frac{3}{4}$ to 4 inches the mortality is least; above 4 inches it reaches its highest rate; removal of the patella increases the mortality from 2.34 per cent., not removed, to 27.3 per cent.; in excision for disease the greatest per cent. died from the operation (37), a less per cent. from

[1] R. Volkman. [2] Quain's Anatomy. [3] H. Culbertson.

other diseases (28.6), and the least per cent. from the original disease (20.2); in excision for shot injuries an equal number die from the injury and the operation; in excision for shot injuries the mortality is mainly attributable to the character of the injuries sustained, 42.2 per cent., and to the supervention of other diseases, 15.5 per cent., the deaths traceable to the operation being but 4.4 per cent. It is noticeable that exsections at the knee-joint for disease are becoming more and more successful; for example, before 1850 the mortality was 53.48 per cent.; 1850-60 it was 30.73 per cent.; 1860-70 it was 21.0; 1870-4, 16.9 per cent.

The usefulness of the limb is thus recorded: In excisions for disease in 420 cases, 14.3 per cent. were perfect, 42.4 per cent. were useful, 4.6 per cent. not useful, and 17.8 were amputated; for injuries, in 17 cases, 17.6 per cent. were perfect, 64.7 per cent. were useful, and 11 7 per cent. were amputated; for shot injuries, in 17 cases, 58.8 per cent. were useful, and 23.5 per cent. amputated; in 46 cases of excision for deformity, 19.5 per cent. had perfect, and 67.8 per cent. had useful limbs; the amount of bone removed varied from ½ an inch to over 4 inches, but the usefulness did not depend upon the extent removed; the removal of the patella secures a greater degree of usefulness than its retention in the proportion of 76.9 per cent. of the former to 31.4 per cent. of the latter.

From these facts it would appear that this excision gives a large percentage of useful limbs; but those who believe that the value of the limb depends upon a permanently firm, unyielding, osseous union of the femur and tibia, will conclude that the recorded results must be taken with some allowance, for too often the union proves to be fibrous and has been followed by amputation,[1] or the limb bends under constant use, or bows outward or inwards, or disease recurs.[2] But great progress has recently been made in perfecting excision at this joint, and limited motion is no longer regarded as impairing its function.[3] The results that have followed the efforts that have been made to preserve the natural relations of the fibrous structures and muscles,[4] give gratifying proofs that the knee-joint will be no exception to the rule that excision should, as far as practicable, restore the functions of joints.

Present experience indicates that excision should be had recourse to only in those cases where the disease begins to endanger life, where hectic fever has set in, the patient loses flesh, the existence of an intra-articular suppuration manifests itself, and a long-continued rational treatment has failed;[1] the number of fistulæ or abscesses in the neighborhood of the joint is of little importance in deciding the question, as they may exist without grave implication of the joint itself, and atonic caries may exist with cheesy-like matter, in the joint, and destruction of ligaments, with little discharge.[1]

On the other hand, as a general rule, excision is not indicated, (1) when the patient is under five or over forty-five years of age; for in the first case there is a possibility of recovery without an operation, and a risk that excision would check the growth of the limb, and in the second case, the advantage of excision over amputation is not sufficient, in the most favorable cases, to balance the in-

[1] R. Volkman. [2] T. Holmes. [3] C. Hüter. [4] Von Langenbeck.

creased risk;[1] (2) when the disease is of recent origin, or limited to the synovial membrane, as in simple hydrarthrosis, however long it may have continued, for a natural cure may still often be obtained by position, rest, extension, and constitutional and local treatment;[2] (3) when there is satisfactory evidence of the presence of organic visceral disease, as phthisis; (4) when there is caries of the articular ends of the bones in a healthy patient, for the disease may often be brought to a successful termination by incision and the removal of the dead bone,[3] and the passage of setons of oakum or perforated rubber tubing through the joint to secure complete drainage and the escape of carious particles;[4] (5) when the disease has lasted many years and the process of natural cure is well advanced, for by placing the part in proper position, securing rest and aiding the natural efforts, recovery with anchylosis may be obtained;[5] (6) when shot injuries involve the joint, for if not severe, expectant treatment will give the best results, but if severe, amputation of the thigh should be performed; even in traumatic suppurations in consequence of penetrating wounds or severe contusions, well-managed, conservative treatment, with the plaster of Paris bandage, ice, incisions at the proper time, injections of concentrated nitrate of silver, extension if necessary, will save more patients than secondary excision.[6]

The following suggestions as to the extent of the excision are important: The patella should not be removed, unless diseased, as the preceding facts show a large per centage of recoveries when it is undisturbed; it is also essential to the formation of a firm, well applied flap;[6] if carious, the diseased part may be removed with the gouge or forceps; in excision of the knee-joint in children, remove at first a thin slice of bone, and, in case this should not suffice, with the gouge scrape out carefully the softened and broken-down osseous tissue, leaving the much thinned cortical substance with the periosteum, behind; the epiphyseal cartilage is often by this means laid entirely bare from the side of the joint; if perforated with fistulous openings a small spoon must be introduced and every particle of diseased tissue removed; in very young children it will often even not be necessary to remove any part of the tibia with the saw, it being practicable to remove the diseased part with the spoon; if the epiphyseal cartilage can be saved only in part, no more should be sacrificed than is actually necessary.[6]

The method of operation will depend upon the kind of joint sought to be obtained; if union of the excised bones is necessary, the U-shaped incision is in general preferable to others, as it permits the removal of any necessary amount of bone without injuring the soft

[1] T. Holmes; J. Ashurst, Jr. [2] J. Ashurst, Jr. [3] T. Bryant.
[4] L. A. Sayre. [5] J. Ashurst, Jr.; T. Bryant. [6] R. Volkman.

parts, and both corners of the wound are situated as low as the anatomical conditions will allow.[1] If an attempt is made to retain motion, a lateral incision [2] is to be preferred, which admits of exsection with the least destruction of the ligamentous tissues of the joint. In exsection designed to secure union, the articular surfaces should be so divided as to give a forward angle at the point of union; this is secured by sawing the bones in the lines *h*, *k*, and *i*, *j* (Fig. 151); the amount of bone removed must of course depend upon the extent of the disease.

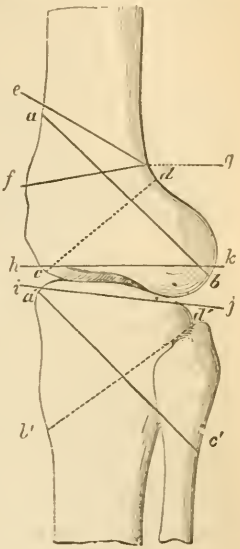


Fig. 151.

Exsect as follows:[3] The leg being slightly flexed on the thigh, make a curved incision, commencing at the insertion of the internal lateral ligament into the inner condyle of the femur, and passing just below the lower extremity of the patella, terminate it at the same point on the external aspect of the joint; the lateral incisions should not be made lower than the insertion of the lateral ligaments, to avoid division of the articular arteries; carefully remove all diseased and degenerated tissues; reflect this flap upwards (Fig. 152); remove the patella, if diseased, if not, leave it undisturbed and divide the lateral and interarticular ligaments; pass a fold of cloth through the joint, and draw it firmly under the extremity of the bone to be sawn, thus completely isolating the soft parts behind; apply the saw first to the extremity of the femur, and then to the articular head of the tibia; cleanse the wound, and wire the bones together.

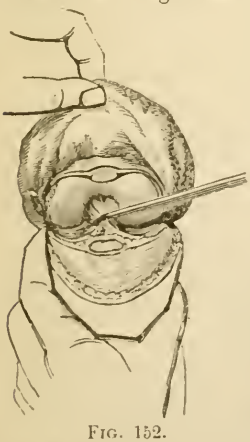


Fig. 152.

The wire selected should be the annealed iron-wire, and it should be inserted at two points corresponding to the insertion of the lateral ligaments.

Subperiosteal resection, with lateral curved incision, is made as follows:[2]

[1] R. Volkman. [2] Von Langenbeck. [3] J. R. Wood.

2, 2 (Fig. 153) Extend the knee and make a curved incision five to six inches long on the inner side, beginning two inches above the patella, at the inner border of the rectus femoris muscle, its convexity looking backwards, passing over the posterior edge of the internal condyle and ending on the inner side of the crest of the tibia, two or three inches below the patella. In the upper part of the wound is the vastus internus, beneath which the tendon of the adductor magnus presents itself; in the lower portion the tendon of the sartorius muscle is seen; these tendons must not be injured; cut through the internal lateral ligament in the line of the joint; separate the internal insertion of the capsule from the anterior surface of the internal condyle as high as the vastus internus: detach the internal alar ligament from the anterior border of the tibia to the middle line; flex the knee, and, as it is again slowly extended, by a powerful effort luxate the patella outwards; divide the crucial ligaments, and to separate the posterior crucial ligament from the spine of the tibia rotate the internal condyle of the tibia forwards; divide the external lateral ligament together with the adjoining portion of the capsule, by a free crescent-shaped incision, carried several lines below the tip of the external epicondyle; the joint now gaps widely; cut the posterior wall of the capsule; push the articular heads of the femur and tibia successively forward, and saw them off; if it is necessary to remove the patella, cut around it with the knife at the border of its cartilaginous surface, and then, by means of the periosteal knife, peel it out of its periosteum, so that the latter continues in connection with the ligamentum patellæ and the extensor tendons. Before the wound is closed, a strong drainage-tube is inserted, and allowed to protrude at the most depending part. It is also useful to make a counter-opening out of which the other end of the drainage-tube is allowed to hang, as also one through the upper attachment of the capsule of the joint.

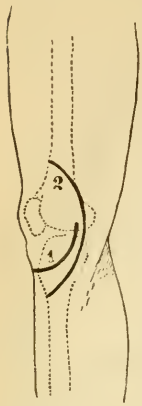


FIG. 153.

The after-treatment is generally very prolonged and tedious, for the average time in excision for disease in recovered cases is one hundred and seventy-eight days, and in fatal cases fifty-eight days. The conditions to be secured and maintained, of the greatest importance for success, are, (1) proper coaptation of the cut surfaces, and (2) complete immobility of the parts. These conditions are secured by apparatus which fixes the limb immovably, and yet leaves the excised parts so exposed that dressings may be renewed without disturbance of the bones. The gypsum splint and bandage, when judiciously applied, give the most satisfactory results. Of several forms the following meets all the indications most perfectly;[1] provide a compress by folding a strip of firm cloth, or lint, extending from just below the tuber ischii nearly to the heel, twelve times together, and of such width as not to touch the angles of the incision; dip it in a solution of plaster of Paris, and apply it to the posterior surface; retain it by gypsum bandages, so applied as to leave the front part of the knee uncovered; an iron brace may be added over the

[1] P. H. Watson; F. Esmarch.

knee for strength.[1] Or, make a wooden concave splint to the calf of the leg and back of the thigh, but narrow at the knee; also an iron rod for suspension, apply the dressing thus: Pad the posterior splint with lint or cotton-wool, and cover that part corresponding to the site of the wound with gutta-percha cloth, or hot paraffine; place the limb in position and carefully adjust it; place the iron rod on the front and lay folded lint between it and the limb at the groin, at the upper part of the tibia, and at the bend of the ankle; apply an open woven roller bandage around the whole dressing from the toes upwards except at the site of the wound; over this apply the gypsum bandage in two or three layers; when the dressing is firm, suspend the limb by the hook; the wounds may now be dressed without disturbing the part.

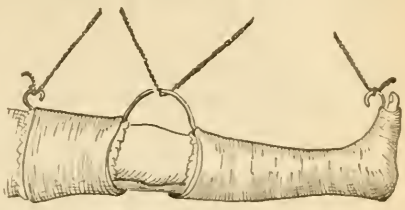


FIG. 154.

6. **The hip-joint** is a large ball-and-socket joint, in which the globular head of the femur is received into the acetabulum or cotyloid cavity of the innominate bone; the articulating surface of the acetabulum is formed by a broad, ribbon-shaped cartilage occupying the upper and outer part, and folded round a depression which, extending from the notch, is hollowed out in the bottom of the cavity, and is occupied by delicate adipose tissue covered with synovial membrane; the articulating surface of the femur presents a little beneath its centre a pit in which the round ligament is attached; movement is allowed in every direction, extension being limited by the anterior fibres of the capsular ligament, and flexion by the contact of the neck of the femur with the acetabulum.[2]

The results of excision are as follows: For shot injuries the mortality is 89 per cent. in a total of 121 cases; at the different periods it is as follows: primary, 36.7 per cent; intermediate, 48.1 per cent.; secondary, 15.2 per cent.,[3] giving a large preponderance in favor of the secondary operation. For disease, the mortality is 45 per cent. in a total of 426 cases; the most favorable age is 1 to 10 years; the most favorable period is when the disease has existed 12 to 15 months; the general mortality is greater in complete than in partial excisions. There is but little difference in the mortality when the head and neck, or the head, neck, trochanters, or the head, trochanters, and upper part of the shaft are removed, provided the amount of pelvic bone excised is limited; the mortality centre is the head of the femur, the rate diminishing as the bone is removed outwards to the shaft and increasing as it advances upwards upon the pelvis.[3] The usefulness of the limb after excision for disease is equivalent to 93.8 per cent. of the recovered cases; complete excision gives a better result in re-

[1] R. Volkman. [2] Quain's Anatomy. [3] H. Culbertson.

covered cases than partial, the former having 45.8 per cent, and the latter 35.8 per cent. perfect limbs, and the former having 48.6 per cent. and the latter 56.6 useful limbs; after excision for shot injuries 3.9 more or less useful limbs and 5 imperfectly useful limbs are recorded in 119 cases.[1]

The indications for exsection are as follows: In compound dislocations[2] in shot injuries when the head is shattered by the ball, or the ball is impacted in the head;[3] in disease, when suppuration and disorganization of the textures of the joint continue unrelieved by ordinary treatment, and the patient's health is in fair condition.[4] Superficial or limited acetabular disease does not interfere with the performance and good results of excision of the head of the femur; even when the acetabulum is much involved, or pelvic suppuration exists, it is important to afford a free escape to the pus by the removal of the head, neck, and great trochanter of the femur.[5] It should not be attempted in cases in which abscesses form with little or no fever, the nutrition of the patient remaining satisfactory; nor when anchylosis is complete, though free suppuration is present.[3] In general, the following conditions should guide in deciding to exsect for disease: (1) in chronic coxitis with formation of abscesses and fistulous openings, the suppuration being abundant, with fever at night, and progressive weakness; (2) when an acute suppurating coxitis, with high increase of temperature, supervenes upon a chronic one in which dry granulations without suppuration have filled the acetabulum; (3) when an iliac abscess which is forming shows that pus has perforated the acetabulum and entered the pelvic cavity; (4) when during suppuration, the head of the femur has separated and left the acetabulum.[3]

The period of operating should be primary in compound dislocations and shot fractures. In disease it has not yet been accurately decided what is the earliest stage of its course in which the operation is justifiable, but the evidence strongly corroborates the opinion that usually it is delayed too long.[5] The surgeon cannot commit a greater error than by delaying excision too long in severe cases, and operating only when the patient is excessively debilitated.[3] Though the mortality would seem to diminish in proportion as the shaft is removed, yet there can be no doubt that, as a rule, the extent of the incision should depend upon the amount of disease; if limited to the head, that part alone should be removed;[6] if the neck is carious, the trochanter may still be preserved; but if the latter is involved, the bone must be divided at the trochanter minor.

The methods of operation are numerous, but the single incision along the axis of the trochanter, with subperiosteal removal of the

[1] H. Culbertson. [2] F. H. Hamilton. [3] R. Volkman.
[4] L. A. Sayre; T. Annandale; L. Verneuil; C. Hüter. [5] T. Annandale.
[6] Von Langenbeck; Sheede; C. Hüter.

bone, most nearly meets the anatomical indication of the part. Of the several arteries distributed to this region, namely, the gluteal, sciatic, obturator, external and internal circumflex, and the superior perforating by anastomosis, the only one which approaches the line of this incision near enough to be incised before dividing into branches of distribution too small to give rise to noticeable hæmorrhage, is a twig of the internal circumflex, which, at one eighth to one fourth of an inch from the insertion of the obturator externus, breaks up into its terminal divisions; this branch may be avoided by keeping the point of the knife well against the bone, and dividing the tendon of the obturator externus muscle in the digital fossa.[1]

Exsect as follows[2]: (Fig. 155) The patient lying on the sound side, with a strong knife commence an incision, 1, 1 (Fig. 155), at a point midway between the anterior inferior spinous process of the ilium and the top of the great trochanter; carry it in a curved line over the ilium, in contact with the bone, across to the top of the great trochanter; extend it not directly over the centre of the trochanter, but midway between the centre and its posterior border; complete it by carrying the knife forward and inward, making the whole length of the incision four to six or eight inches, according to the size of the thigh; if the periosteum has not been divided by the first incision, carry the point of the knife along the same line a second or third time; an assistant separating the wound with the fingers or retractors, the great trochanter (Fig. 157), is exposed; with a narrow thick knife make a second incision through the periosteum only at right angles with the first at a point an inch or an inch and a half below the top of the great trochanter, opposite or a little above the lesser trochanter, and extend it as far as possible around the bone, making sure that the periosteum is freely divided; at the junction of the two incisions of the periosteum introduce the blade of the periosteal elevator, and gradually peel up the periosteum from either side with its fibrous attachments until the digital fossa has been reached; with the point of the knife applied to the bone divide the attachments of the rotator muscle, and continue to elevate the periosteum, carefully avoiding rupturing it at any point; when the periosteum is removed as far as necessary, adduct the limb slightly, de-

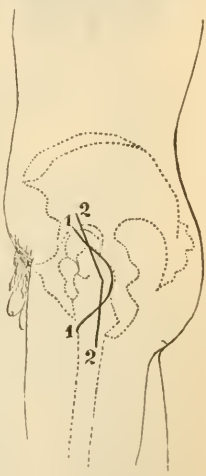


FIG. 155.

[1] J. A. Wyeth. [2] L. A. Sayre.

press the lower end of the femur sufficient to allow the head of bone to be lifted out only so far as is requisite to permit its removal with the saw *g*; divide the bone just above the trochanter minor, and remove the fragment; if the head of the bone cannot be raised before division on account of the involucrum, saw the bone first and then remove the head; if the shaft at the point of section is necrosed, expose and exsect more; examine the acetabulum and if found diseased remove all dead bone; if perforated, the internal periosteum will be found peeled off, making a kind of cavity behind the acetabulum, and all diseased bone must be very carefully chipped off down to the point where the periosteum is reflected from sound bone; all sinuses must be thoroughly cleaned of particles of bone and false membrane; cleanse the wound thoroughly, fill it with Peruvian balsam, and stuff it with oakum, always avoiding cotton or lint, and close only the extremities with stitches.[1]

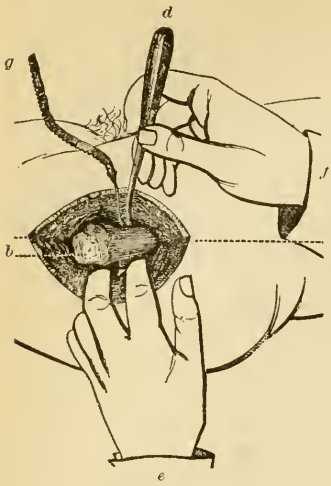


FIG. 156.

Or, make an incision 2, 2 (Fig. 155),[2] commencing about three inches below the crest of the ilium, and the same distance posterior to the anterior superior spine, downwards to the trochanter major, and then along the centre of the shaft of the bone.

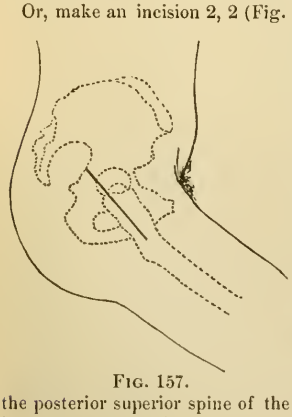


FIG. 157.

An exploratory incision may be made by entering the knife immediately above and in a line with the posterior margin of the great trochanter, and making an incision sufficiently long and deep to allow the finger to explore the joint; extension of this incision upward or downward two inches will admit of excision of the head of the femur.[3]

The following method[4] is approved: Make a longitudinal incision over the great trochanter 2½ to 4 inches in length, in a line with the axis of the femur, and directed to the posterior superior spine of the iliac bone; two thirds of the incision is made in the glutei muscles above the trochanter, and one third on the trochanter;

[1] L. A. Sayre. [2] L. Ollier. [3] T. Annandale. [4] Von Langenbeck.

separate the muscles down to the neck of the femur, in the direction of the longitudinal incision until the neck of the femur and the margin of the acetabulum are entirely free; incise the capsule in a longitudinal direction, and notch it slightly on both sides at the margins of the acetabulum; while the finger is passed into the wound, cause rotation of the femur, which enables the operator to separate all the muscular attachments on either side of the incision; the head may be dislocated and sawn off, or the bone may be divided in place and the fragment removed (Fig. 157).

The operation [1] by a horizontal incision at the front part of the joint has been advised; the incision commences external to the crural nerve, and involves the sartorius, rectus, and tensor vaginæ femoris muscles. It is not well adapted for real excision of the joint, as it admits only of an operation on the neck of the femur, unless the incision is very large; as the wound is in front of the joint it does not favor free discharge of matter; the incision is, however, well adapted for simply dilating fistulæ situated in front of the joint, or for gouging out the joint by means of sharp spoons, or for the extraction of the head of the femur when separated.[2]

The after treatment requires great care and unwearied patience; in order that the excised joint may be kept at rest, the wound must be so placed and exposed that the dressing and cleansing may be accomplished without moving the part; during the first weeks it is necessary to keep the acetabulum and the surface of the femur well apart, and the soft parts well stretched, as in excision of the elbow, shoulder, and the ankle-joints; by this means healthy granulations make a more rapid progress, and the pelvis and femur come into close contact by the contraction of the granulations and their formation into cicatricial tissue.[2] The wire cuirass is the best apparatus to meet these indications, especially when the patient is a child (Fig. 158).

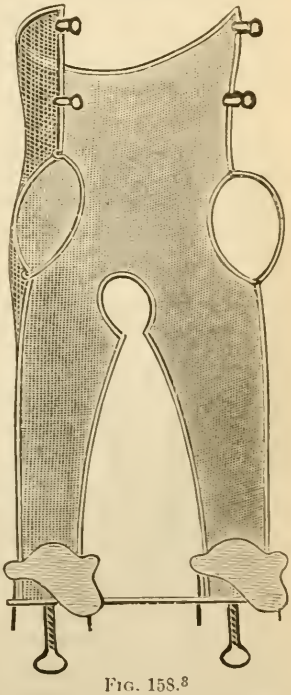


Fig. 158.[3]

Apply it as follows: The cuirass being properly padded, place the patient in it so that the anus is opposite the opening and free from any obstruction; dress the well leg as follows: make it perfectly straight, then screw up the foot-rest until it is brought firmly against the heel; place a pad between the rest and the foot to absorb perspiration; cover the instep with cotton or blanket, and carry a roller firmly round it and the foot-rest, and thence up over the limb; before applying it, place a piece of pasteboard, leather, or several folds of paper, over the leg, knee, and thigh to pre-

[1] Rozer. [2] R. Volkman. [3] C. H. & Co.; W. F. Ford.

vent the slightest bending of the knee; carry the roller around the perineum, and over the outer arm of the instrument, and several times back through the perineum, and then across the pelvis, by which means the well limb is made a firm counter-extending force; dress the operated leg as follows: apply two strips of adhesive plaster, two to four inches in width, according to the size of the leg, one upon either side, extending above to the sinuses, and below sufficiently to admit of their attachment to the foot-rest where extension is made; screw up the foot-rest to meet the heel, and bring down the ends of the plaster and fasten them securely around it; then extend the foot-rest slowly and gradually by means of the screw, until the limb is brought down to its full extent; if, by long contraction, the adductors and tensor vaginæ femoris do not yield, divide their tendons and fasciæ subcutaneously; now apply a bandage from the toes over the entire limb to the wound; place a mass of oakum around the wound to absorb the discharge, and continue the roller firmly over it to the body; this dressing will probably not require to be changed for from forty-eight to sixty hours, or until the dressings are moistened with the discharges, when the oakum must be removed, the wound cleansed with carbolic solution, and again filled with Peruvian balsam, and dressed as before; after this, change the dressings once or twice daily according to the discharge, and remove the patient from the entire instrument as often as may be necessary; the well leg should be removed at least once a week, and free movement given to all the joints; the cuirass should be used for a month or two, when a long or short hip splint may be substituted, and the patient allowed to exercise.[1]

In the absence of this apparatus, the limb may be placed in extension, supported by sand-bags or pillows,[2] or it may be encased in plaster of Paris, with suitable openings for the discharges.

The gypsum bandage is best adapted to adults, and is most serviceable when applied with a strip of iron spanning the joint, and maintaining the thigh and pelvic portions in position (Fig. 159);[3] this stirrup of steel may be movable by means of a bracket, making extension possible; its construction and application are apparent. With children, extension by the application of weights and proper positions of the limb are the best means; the patient may be placed on a divided mattress, of which the two different parts, exactly corresponding to the spot where the excision was made, are separated by an interstice of several inches.[4]

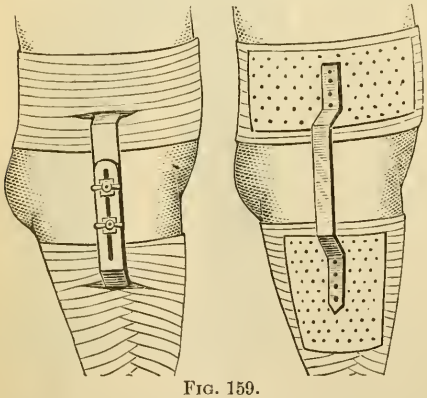


Fig. 159.

[1] L. A. Sayre. [2] T. Annandale. [3] C. F. Stillman. [4] R. Volkman.

III.

THE MUSCULAR SYSTEM.

THE MUSCLES; THE TENDONS; THE FASCIÆ; THE BURSÆ.

CHAPTER XVIII.

INJURIES OF THE MUSCULAR SYSTEM, AND SPECIAL OPERATIONS.

I. MUSCLES.

1. **Ruptures of muscles** may be partial or complete. The former are sprains, and occur in severe wrenches of the limbs or back; they are restored by rest and soothing applications, and when the soreness is relieved, by gentle movements, massage and galvanism. A muscle may be completely ruptured subcutaneously when the whole force is thrown in a violent and unexpected manner upon one or two muscles, or in violent paroxysms of muscular spasms, as in tetanus; the point of separation is commonly at the junction of the muscle with the tendon; the accident is attended with extreme pain, resembling that occasioned by a smart blow from a stick, and often by a distinct sound like the snapping of a cord; all motion of the part is either impossible, or is accompanied by such severe pain, with spasmodic twitching, as to cause the patient to desist; deep indentations are found at the seat of rupture by retraction of the divided ends, and often considerable swellings; there is always extravasation of blood with discoloration of the skin. Simple subcutaneous ruptures of muscles are not serious injuries.[1] Place the part in a position most favorable for relaxing the muscles, and bringing the surfaces in apposition, and support it with splints and other appliances; maintain the extremities of the separated muscle in contact by evenly applied flannel bandages or laced belts, aided in some

[1] T. Billroth.

cases by a strip of leather or gutta percha. At first there is a connective tissue intermediate substance which soon undergoes such shortening and atrophy that a firm tendinous cicatrix forms; functional disturbances rarely remain of any considerable amount, though there may be some weakness of the extremity and loss of delicate movement.[1] If the rupture involve the skin also, the injury is grave in proportion to the extent of the laceration; if the muscle protrudes at the wound, it must not be cut away but reduced to position; if necessary, enlarge the wound of the skin, and after replacement close the wound with antiseptic dressing and treat it with a view to secure union without suppuration.

2. **Incised wounds of muscles** are followed by retraction of the cut ends. There is always observed a peculiar inversion, subsidence, or tucking in of the muscular fibres at the divided parts, so that nearly all the fasciculi direct their cut ends towards the subjacent bone or fascia; in repair, new muscular fibres are never formed, but the retracted portions become inclosed in a tough, fibrous bond of union; in some cases the cut ends of the muscle are imperfectly united, but the action of the muscle is not lost, for one or both of its ends, acquiring new attachments to the subjacent parts, still act, though with diminished range.[2] Whether the wound is open or subcutaneous, approximate the cut extremities of the muscle as perfectly as possible both by position and dressings, and retain them in this condition by absolute rest; if the wound is open, employ deep sutures to muscles and skin, with bandages above and below fastened over the wound so as to give uniform support and prevent separation.

II. TENDONS.

1. **Rupture of a tendon** is caused by a sudden action of its muscles, as of the tendo-Achillis in springing upon the toes; or violence from accidents, as in dislocations; the tendon yields more frequently than the muscle, the point of separation being at the junction of the tendon to the muscle, or at the attachment to the bone; the rupture occurs with a snap and a shock as if the part had received a sharp blow, with sudden and comp'ete loss of function. In treatment, the divided ends must be as accurately approximated as possible, and retained until firm union is established; though close adaptation can not be hoped for, yet a perfect union, with recovery of the action of the muscle, usually takes place, for the severed ends are brought closer and closer together by the contraction of the new material as it becomes perfected, and the remaining deficiency is fully compensated by the accommodating nature of the muscle. The appliances

[1] T. Billroth. [2] Sir J. Paget.

in the treatment of ruptured muscles and tendons are the same. The following muscles and tendons are more frequently ruptured : —

(*a.*) **The triceps extensor cubiti** usually ruptures at the insertion into the olecranon; bandage the arm from above downwards, with a splint in front to keep it extended; or apply adhesive strips over the body of the muscles, and allowing them to cross over the olecranon, make firm traction and fasten the ends over the splint on the anterior surface.

(*b.*) **The biceps flexor cubiti** is liable to have the tendon of its long head ruptured, the other usually ruptures at a later date;[1] bandage the arm upwards, and fix the limb with the hand upon the opposite shoulder; union rarely occurs.

(*c.*) **The quadriceps extensor cruris** may be ruptured near the patella; place the limb on a straight splint, the foot elevated; fix the patella with adhesive strips so that it cannot descend; apply adhesive strips over the entire compound muscle, each commencing at the upper limits of the thigh; but all converging to the patella; to the combined strips united, attach a rope passing over a pulley, and add a weight sufficient to maintain the parts in apposition.

(*d.*) **The tendo-Achillis** may rupture, or be detached from its insertion into the os calcis; immediately apply a bandage to the leg from above downwards, over the calf, but stop short of the point of separation, lest the tendon be forced down to the bone and form attachments. Extend the foot on the leg, flex the leg on the thigh, and fix the parts in this position by attaching a belt placed above the knee to the heel of a stout slipper on the foot, if detached from its insertion.

2. **Incised wounds of tendons** are followed by contraction of the muscle or the displacement of the attached part. They are recognized by loss of function, and the depression at the point of separation. This is one of the few structures of the body capable of complete reproduction, and the extent of the new part varies within given limits, according to the separation of the cut tendon.[2] The obstacles to perfect union of tendon are: failure to maintain the parts in apposition, too early use of the limb, division in dense fibrous sheaths, the extremities becoming adherent to the inner surface of the sheath. Place and maintain the limb in such position as to secure easy apposition of the cut extremities; if the wound is open, first unite the cut extremities of the tendon by suture, as carbolized catgut, and then close the external wound; avoid putting the tendon on the stretch for several weeks.

III. BURSÆ.

Wounds of bursæ are liable to lead to inflammation and suppuration; and secondarily, involve the neighboring joints. Cleanse and disinfect the wound, and endeavor to secure immediate union; if pus form, open the abscess under carbolized spray, and apply antiseptic dressings.

[1] T. Bryant. [2] W. Adams.

CHAPTER XIX.

DISEASES OF THE MUSCULAR SYSTEM AND SPECIAL OPERATIONS.

I. MUSCLES.

1. **Inflammation** of muscles, myositis, is rarely an idiopathic disease; it may occur, however, in the tongue, psoas, pectoral, and gluteal muscles, and in those of the thigh and calf of the leg; the acute form usually terminates in abscess, although resolution has been observed.[1] After an injury, the symptoms usually appear several weeks later, and result from some lack of repair in the injured part, due to the want of the necessary rest which an injured muscle so much requires in the process of healing.[2] It begins with parenchymatous swelling of the muscular fibres, and passes rapidly into suppuration and abscess; the bellies of entire muscles, as the psoas, may be converted into pus; but more commonly the abscess is limited to a spot varying in size from a pea to a walnut, according to the cause in each particular case; the most trifling inflammation affecting the striped muscles of the trunk and limbs occasions the most violent disturbance of function; the muscle rests in a state of contraction, and any attempt to extend it is most strenuously opposed by the patient on account of the intense pain to which it gives rise.[3] In large abscesses which are compressed by strong fasciæ there is contraction of the muscles in the substance of which the abscess develops, as in psoitis; but in small and not very painful abscesses, and in traumatic inflammations of the muscles, there is usually no contraction.[1] Resolution of the inflammation should be attempted by rest and the application of ice-bags. When pus forms, warm moist applications must be made, and as soon as abscess is detected it should be opened, and with antiseptic dressings if a large muscle is involved.

II. TENDONS.

1. **Inflammation** of tendons, and their sheaths, is liable to follow sprains, or other injuries. The sheaths may inflame, with exudation of fibrinous serum, which often induces temporary or permanent adhesions of the sheath to the tendon; or suppuration may occur with necrosis of the tendons; there is now fever beginning with a chill; if the inflammation and suppuration extend, the fever becomes continued and remittent in form; if intermittent chills occur, there is great danger. Inflammation of the sheaths, arising from unknown

[1] T. Billroth. [2] T. Bryant. [3] E. Rindfleisch.

causes, begins as an acute phlegmon, the cellular tissue participates, and the limb swells greatly. The symptoms at the first are pain on motion, and slight swelling; sometimes a friction sound is present, or grating in the sheath perceptible to the ear or hand. Resolution may occur without suppuration, the limb remaining stiff a long time, as the adhesions between the sheath and tendon do not break down until after months of use; if extensive suppuration follow, the tendons usually become necrosed and escape from the abscesses as white threads or shreds, followed by permanent stiffness of the fingers. The treatment of slight inflammation of the tendons, with crepitation, is rest on a splint and local application of tincture of iodine, or add a blister.[1] If the symptoms are more severe, elevate the limb and apply ice; if this is painful, use hot fomentations over a large surface; if the inflammation extend, with throbbing, and hardness, make a free incision along the centre of the sheath, to relieve the tensely strangulated tissues, even though no pus is present.[2] If pus is detected, make numerous openings, and secure free drainage from position or tubes; if the disease still progresses, and the patient sinks, amputation of limb may be necessary to save life.[1] In the more chronic states, where abscesses burrow, though free openings have been made, resort to pressure with pads of lint soaked in liquor plumbi acetat., and combine tonics and good diet.[2]

The synovial sheaths suffering chronic inflammation may become distended with a fluid, jelly-like and containing white bodies. The sheaths in the hand are most frequently affected; there is a gradual formation of a swelling in the hollow of the hand and the lower end of the volar side of the forearm, and the fluid may be felt passing in the sheath to the forearm under the ligament of the wrist; the fingers are generally flexed and cannot be fully extended; the movements of the hand and fingers are somewhat limited, but there is no pain; the fluid is jelly-like, with white bodies. In other cases there is a partial hernia of the sheath, with dropsy, a ganglion forming a kind of sac-like protrusion about the size of a pigeon's egg, and filled with synovia; it appears most commonly on the dorsal surface of the wrist, in connection with the extensor tendons; it also contains thick mucus, and white bodies, like melon seeds.[1] In treatment avoid any operation which might cause suppuration. In dropsy of the sheath, open the sheath antiseptically, using the spray continually until the carbolized dressings are fully applied, and insert a long tube for drainage. If the antiseptic method cannot be applied, avoid operating as long as possible, and then proceed cautiously, as follows: Open the sheath either by incision or puncture, and inject iodine; if puncture is made, select a medium-sized trocar which will

[1] T. Billroth. [2] J. L. Clarke.

allow the escape of the fibrinous bodies; inject tepid water through the canula to force out these bodies; when all has been removed, inject slowly a syringe full of a mixture of equal parts of tr. iodine and water, or add an equal quantity of iodide of potassium; remove the canula, cover the wound with a small compress, bind up the hand and forearm carefully and place it on a splint; if the tension subsequently becomes severe, remove the dressings, close the puncture with plaster and paint with iodine.[1] In the case of ganglia, attempt rupture with the thumbs pressed firmly upon it; failing, open it antiseptically, or by subcutaneous free incisions of the sac, and evacuation of its contents into the connective tissue; the limb should be kept at perfect rest during the treatment.

III. BURSÆ.

Bursæ are deep-seated or subcutaneous sacs to prevent friction; the former are interposed between a muscle or its tendon and a bone or the exterior of a joint, or between two muscles or tendons, and frequently communicate with the cavities of joints; the latter lie immediately under the skin, interposed between it and some firm prominence underneath.[2] From their location and function, they are peculiarly liable to injury, hence to inflammation.

Inflammation of the deep-seated bursæ appears as local painful swellings, which are often mistaken for common phlegmons. The inflammation may resolve with more or less consolidation, or terminate in suppuration, or assume a chronic form with an accumulation of fluid, — dropsy. The early treatment should be rest and cold; if pus form, they must be opened cautiously with antiseptics, and healed as quickly as possible; if they become dropsical, use blisters, tincture iodine, and pressure, and open them for radical treatment only when obstinate, and then with antiseptics. The bursæ, which occasionally enlarge, are numerous in the region of large joints, as the hip, the knee, the shoulder, and elbow; the following are examples: —

(*a.*) **The deltoid bursa**[1] at times communicates with the joint through the bicipital groove; when inflamed there is swelling around the shoulder joint, pain and crepitation on movement, simulating mischief in the joint; it may become distended with simple fluid, or loose bodies; the treatment should be absolute rest of the arm and blisters; it should be opened only after grave consideration, and when obstinate, and there is bulging in front of the deltoid. If antiseptics are used there is much less danger.

(*b.*) **The quadriceps extensor cubiti bursa**[3] often inflames and the swelling is distinguished from that of the knee by being limited to the upper border of the patella, especially noticeable when the patient stands, and fluctuation is above and not through the joint. The treatment is rest, tr. iodine, blisters, and when very obstinate, tapping; if it suppurate it must be freely opened, but with antiseptics.

[1] T. Billroth. [2] Quain's Anatomy. [3] T. Bryant.

(c.) **The ligamentum patella bursa,** distended by fluid, presents itself conspicuously on both sides of the ligamentum, extending from the tubercle to the top of the tibia; it is painful after exercise, swollen, and tender: the treatment is rest, blisters, and tr. iodine; as it often communicates with the joint, operations, as incision, puncture, the insertion of a seton, are very dangerous.

Other bursæ which are liable to inflame, and which must be treated on the same principles, are located as follows: Under the tendon of the subscapularis; in the sheath of the long head of the biceps; between the tendon of the latissimus dorsi and the inferior angle of the scapula; under the insertions of the tendon of the biceps into the radius; under the tendon of the triceps; several at the hip, the largest beneath the conjoined tendon of the psoas and iliacus internus; several in the popliteal space; under the insertion of the tendo-Achillis; about the ankle and tarsal articulations.

Of the superficial bursæ those on the patella and olecranon are types; if the inflammation is acute the fluid collects rapidly, the skin is red, the swelling painful, preventing walking; the fluid may wholly or partially be absorbed, or the sac may suppurate, or rupture subcutaneously, or through the skin. The treatment of the acute stage is rest, with cold; and in the chronic stage rest, with tr. iodine, compression, blisters, mercurial ointment, or plasters. Compression[1] by means of a well-padded splint in the ham, and bandaged as firmly as possible with a flannel roller, often effects a cure. But chronic dropsy of this, as of other bursæ, is not always curable by these remedies; more radical measures are required, as injection of iodine, free incision, or extirpation; injections are not dangerous if the patient remains quiet; use equal parts of strong tr. iodine and water; first draw off a portion of the fluid, then inject the preparation, retain it for several minutes, and withdraw whatever will reënter the syringe. If the sac is very thick, it is justifiable to extirpate it entirely, which must be done with great care to avoid injuring the capsule of the joint.[2] After the walls are reached, if the edge of the knife is directed towards the tumor, it may be dissected from the expanded tendon of the quadriceps, and from the patella, without injury to either; remove any redundancy of integument; bring the edges of the flap exactly together; fix the limb upon a well-fitting posterior splint, and secure it by a few turns of a roller inclosing the front of the knee and portions of the limb above and below.[3] Still greater safety is secured by operating and dressing with antiseptics and confining the limb in a fenestrated gypsum bandage.

III. CONTRACTION.

Although contraction can only take place in muscles, yet a wider meaning is generally given to the term, and tendons and fascia may

[1] R. Volkman. [2] T. Billroth. [3] F. H. Hamilton.

become contracted, being shortened and shrunken, and without their normal elasticity.[1]

1. **A muscle** contracts when inflamed, and where there is inflammatory new formation in muscle, cicatricial connective tissue may take the place of the muscle; this process causes the drawing together by atrophy and induces contraction. Contractions may also result from continued direct irritation of certain nerves, or they may have a reflex origin, or follow as a result of long-continued paralysis of antagonizing muscles. Finally, shortening may occur as a result of continued approximation of the points of insertion, as in curvatures of the spine, and clubfoot; this form of contraction, contractured muscle,[2] is an adaptation of the muscle to the new relations of the points of origin and insertion, and is attended with diminished function, and consequently size, adaptive atrophy.[3] The treatment depends upon the cause; during inflammation extension should be maintained to avoid contraction, but if contraction finally occurs, deformity must be relieved by division of the muscle;[4] in paralysis of antagonizing muscles, as in infantile paralysis, contraction must be prevented by well-adjusted appliances; if contraction exist and has so long continued that the muscle has become adapted to its new position,[3] it must be divided before the deformity can be overcome.

2. **A tendon** undergoes contraction, both as a result of inflammation and from long continued position, and not only causes deformities, but aggravates and renders permanent existing deformities. The treatment is the same as in contraction of muscles.

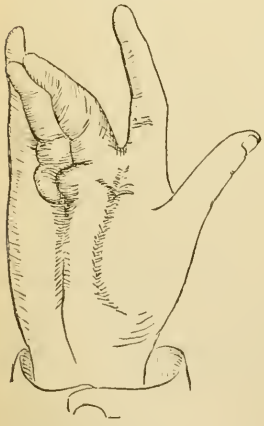


Fig. 160.

3. **The fasciæ** may shrink from the displacement of a part by which the fascia is relaxed, as occurs in the fascia lata during hip-joint disease, or the contraction may occur as a result of a low grade of inflammation, especially in the palmar fascia. This contraction, though sometimes occurring in persons suffering from rheumatism, seems to be due to frequently repeated and protracted pressure of hard substances, as in handling tools. The integument and subjacent fascia inflame, induration succeeds, and adhesion with contraction follows, with flexion of the finger to which the fascia is attached (Fig. 160), at first slight, but progressively increasing until in some cases the ends of the fingers are almost in

[1] T. Billroth. [2] A. Delpech. [3] Sir J. Paget. [4] E. Brown-Sequard.

contact with the palm of the hand. This morbid condition may occur in one or in both hands; the fingers are not usually all contracted to the same degree; the ring finger is generally more flexed than the others, and the little finger more than the index or middle finger. There is little or no pain, except an effort is made to extend the finger, when great resistance is offered and severe pain is induced; indurated and knotty cords can be seen and felt, extending from the palm to the fingers, the firmness of which is greatly increased by efforts at extension; these cords are formed by contracted bands of the palmar fascia together with the closely adherent integument; the skin of the palm is drawn into folds in the form of arcs of circles whose concavities are downwards towards the fingers; in some cases the sheath of the flexor tendon is involved in the vicinity of a single articulation, generally that of the first with the second phalanx. It is distinguished from paralysis of extensors by complete extension of fingers; from cicatrices by the absence of scar; from rheumatism by the healthy state of the joints; from contraction of flexor muscles and tendons by the absence of tension when there is extreme flexion of wrist. The case always progresses unfavorably when untreated, but recovery is probable if the contracted bands are thoroughly divided, and the affected fingers are extended and maintained in that position by proper splints, and passive motion is vigorously and persistently applied. As the treatment is tedious and painful, and must be protracted through several months, the patient should be fully informed of these facts. Secure full anæsthesia; make subcutaneous section as far as practicable at every point where there is tension; if the skin is very adherent divide it, but as slightly as possible; close the wounds with adhesive plaster and place the fingers in an extended position; apply to the back of the forearm, hand, and affected fingers, a metallic splint adapted to the surface, with an intervening layer of lint or cotton wool; secure the fingers to the corresponding portions of the splint by narrow strips of adhesive plaster, and the arm, by a bandage; renew the dressings at intervals of two or three days, and apply passive motion persistently until recovery is completed.[1]

The fascia lata is liable to undergo permanent contraction by long continued spasmodic action of the tensor vaginæ femoris, as in hip-joint disease. Division of the muscle will not always be followed by sufficient relaxation of the fascia; wherever contractions still exist, section must be made with the long tenotome carried under the bands.

[1] W. G. Elliott; A. C. Post.

CHAPTER XX.

GENERAL OPERATIONS ON THE MUSCULAR SYSTEM.

I. MYOTOMY; TENOTOMY; FASCIATOMY.

These several general operations on the muscular system, namely, myotomy, section of muscle; tenotomy, section of tendon; and fasciatomy, section of fascia, are generally classed under the more common term, tenotomy. They are undertaken for the relief of deformities or displacement of parts, caused or maintained by the contraction of muscle, tendon, or fascia, or of all combined. The muscle and its tendon are more frequently alone at fault, but occasionally the fascia is also involved in the contraction. The true value of tenotomy does not consist simply in division of the contracted structures, but rather in substituting for the unyielding tissue a cicatrix capable of being extended, and which will enable the part to perform again its proper function. It follows that to render the operation successful, great discrimination is required in the selection of the muscle to be divided and the point of division, and in the after treatment. In general the operator may select between division of the muscle and tendon, and then preference should always be given to the tendon, owing to the marked difference in the methods of repair of these two tissues, namely, in section of muscle repair is always by fibrous tissue, while tendon and fascia are regenerated. If the tendon has a synovial sheath avoid it if practicable,[1] or if divided, precautions should be taken to prevent inflammation by the use of a tenotome rendered aseptic by immersion in a carbolized solution.

1. **The indications** favorable to tenotomy depend upon the following conditions: (1) The contracted tissues must have undergone such adaptive changes as to render extension by mechanical means impossible or unadvisable; (2) the antagonizing muscles should not be so paralyzed that they are not capable of restoration of function, at least in some degree. To determine these questions the following general rules are useful, and should be fully applied in every case: — (*a*.) The force of the contraction may be tested as follows:[2] If the displaced limb can be brought nearly into position by the force of the hands, the contraction is not so great and permanent that mechanical appliances will not overcome the distortion; but if manual efforts do not greatly improve the abnormal position of the part, a condition exists which renders extension excessively tedious, or quite impossible. (*b*.) The permanency of the contraction is proved thus:[3] Place

[1] T. Billroth. [2] W. Adams. [3] L. A. Sayre.

the part contracted as nearly as possible in its normal position by means of manual tension gradually applied, and then carefully retain it in that position; while the parts are thus placed upon the stretch, make additional point pressure with the end of the finger or thumb upon the parts thus rendered tense, and if such additional pressure produces reflex contractions, that tendon, fascia, or muscle, must be divided, and the point at which the reflex spasm is excited is the point where the operation should be performed; but if the additional point pressure does not produce reflex contractions, the deformity can be permanently overcome by means of constant elastic extension. (*c.*) The paralysis of antagonizing muscles is proved by their atrophy; the loss of voluntary power over them; their insensibility to the electric current: and finally, by the congenital, rather than non-congenital, nature of the distortion, the former being generally due to spasmodic contraction of the muscles involved, and the latter to paralysis of the antagonizing muscles.[1]

2. **The instruments**[2] (Fig. 161) are tenotomes of different construction. The handles should be so marked that the direction of the blade may be known when it is buried in the tissues; the shank should be one to one and three fourths inches long; strong, and firmly inserted into the handle; the blade should be three quarters of an inch to one inch in length, very thick at the heel, very narrow in the cutting portion, and always blunt pointed, the point being somewhat rounded and sharpened from side to side, like a wedge or chisel, so that it will split rather than puncture the tissues; the blades are of various shapes, being straight or curved, having the cutting edge on the convex or concave border; the steel should be properly tempered to prevent breaking in cutting condensed structures. For the division of fascia a longer blade is required, but a probe point is preferable to a sharp point. (Fig. 162.)

Fig. 161.

3. **The operation** is as follows[2]: Anæsthetics are necessary in severe operations; the tendon being made tense, introduce the tenotome flatwise, giving it a slight rotary motion, until the tendon, muscle, or fascia is reached; carry the blade flatwise under the structure to its opposite side, then turn the cutting edge towards the tissue to be divided, the mark on the handle indicating the direction of the edge; press the tendon or muscle down upon the blade, at the same time giving the instrument a slightly sawing motion until the part gives way,

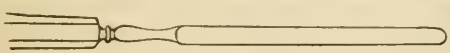


Fig. 162.

[1] W. Adams. [2] L. A. Sayre.

which can be recognized by the finger, and often by a snap; the division being made complete, turn the instrument flatwise and withdraw it, the finger or thumb following and forcing out any blood in the track of the knife and preventing the entrance of air; the wound must be hermetically sealed by applying two strips of adhesive plaster which cross over the cut, but do not surround the limb, and secure them by a roller bandage. (Fig. 163.)

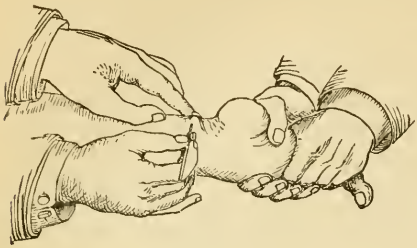


Fig. 163.

4. **The treatment** of the divided tissue should aim to secure reunion of the structure of such length and power as to maintain the proper balance of the forces acting on the part previously displaced. In order to effect this object the deformed part must be restored by such degrees as will not prevent the union of the several tissues; for if restoration is complete immediately after section, the smaller tendons may be so far separated that union will not take place, or the cut ends may unite to their sheaths. If the tendon is large, as the tendo-Achillis, the deformed part may be at once restored,[1] but if the tendon is small, as the posterior tibial, extension should be gradual.[2] The object of gradual extension is not so much to elongate or stretch the new material, as to regulate its length, and the rate at which this is to be accomplished must depend upon the activity of reparation process, and the required length of the new tendons.[2] The period must therefore vary from two weeks in a healthy child, to three or four weeks in the adult, and to five or six weeks in atrophied paralytic limbs.

TENOTOMY IN THE UPPER LIMBS.

The contractions of the muscular system which give rise to distortions of the upper limbs are very numerous, and tend to seriously impair function. Distortions of the fingers are peculiarly disabling, and require judicious treatment. Tenotomy, as a remedial measure, must be applied with great care, especially in the region of the hand, owing to the extended synovial sheaths.

1. **The flexors profundus and sublimis digitorum** are inserted into the phalanges by long tendons running in fibrous sheaths lined by synovial membrane. The deep flexors are inserted into the base of the third row of phalanges, and the superficial flexors into those

[1] J. Syme; L. A. Sayre. [2] W. Adams.

of the second row; contraction of the long flexors consequently flexes the third phalanges, and contraction of the superficial flexors, the second row; section of these tendons is dangerous, owing to the liability to inflammation of the sheaths,[1] and should, therefore, be made with such precautions as will prevent the exposure of the synovial surface to injury or septic matter. The division should be made on the first or second phalanx. The knife blade, having been wet with carbolic solution, enters the point on the side of the second phalanx, near the anterior surface, and having reached the tendon, cut to the bone; withdraw the knife, keeping the thumb of the left hand firmly applied to the wound which forces out any blood; the wound should instantly be hermetically sealed, and several days be allowed to elapse before the finger is fully extended. Section of the tendons in the palm is still more dangerous, owing to the proximity of arteries and nerves, as well as the large synovial sheaths. If the attempt is made to operate in the palm, make the tendon tense, and puncture anterior to the transverse fold of the skin to avoid the arterial arches, on a line with the middle of the metacarpal bones, and cut directly upon the bone; close the wound as in the former case.

2. **The extensor communis digitorum** is inserted into the bases of the third row of phalanges; they have no important surgical relations at points where they are most accessible, namely, the dorsum of the metacarpus. Pinch up the skin over the tendon, and avoiding the veins and articulations, pass the tenotome down to the tendon, and cut towards the bone; if several tendons are retracted, it is better to divide each separately, rather than by a single puncture, as is sometimes advised.

3. **The extensors primi and secundi internodii and ossis metacarpi pollicis**, may fix the thumb in a state of extension; the radial artery passes beneath them where they cross the carpus. Section may be made by bringing the tendons out prominently; flex the extended thumb and abduct, which will make the extensors ossis metacarpi and secundi internodii pollicis prominent below the styloid process of the radius, at a point where the radial artery passes to the dorsum; if the blunt tenotome is inserted through an incision while the tendons are made tense, and kept well applied to it, division may be made without danger. The extensor primi internodii pollicis, lying more external, is now prominent, and may be divided safely where the artery passes under it, over the second phalanx.

4. **The flexor carpi radialis** runs along the radial side, and is inserted into the base of the second metacarpal, and has the radial vessels on its radial border. It may be divided above the wrist, the

[1] T. Billroth.

tenotome entering on the radial border of the tendon, made tense, but inside of the radial artery, and passed beneath it; or, if necessary, the palmaris longus may be divided at the same time; first cut the palmaris longus, and then the flexor carpi radialis.

5. **The flexor carpi ulnaris** runs along the ulnar border, and is inserted into the pisiform bone, and has the ulnar vessels on its radial border. It can be safely divided by making it tense, and puncturing on the radial side, and keeping the blunt tenotome closely applied to the tendon.

6. **The palmaris longus** runs down the middle of the wrist, is inserted into the annular ligament and palmar fascia, and has the median nerve on its ulnar and posterior surface. Section is effected while the tendon in made prominent by passing the tenotome on its ulnar side carefully under it above the wrist or near its insertion, avoiding the median nerve, and cutting towards the skin.

7. **The biceps flexor cubiti** is inserted into the tubercle of the radius; it lies in front of the brachial artery and median nerve; it firmly flexes the forearm when permanently contracted; there is a marked prominence of the body of the muscle, and an elevated cord or band at the bend of the elbow when attempts are made to straighten the limb. Section is to be made above the aponeurotic expansion of the tendon, the contraction of which must be relieved, and from before backwards. Make firm extension of the forearm, and when the tendon is rigid, insert the tenotome at the external border, avoiding the median veins; depress the handle as the blade glides under the skin to the opposite border, turn the edge to the tendon and with a sawing motion divide it; the brachial artery is half an inch behind the tendon, and is not in danger unless the incision is made too freely.

8. **The triceps extensor cubiti** is inserted into the oleeranon and has no other important feature than its relation to the joint on its under surface. Extension of the forearm is caused by contraction of the triceps; it may also prevent reduction of a backward dislocation. Section should be made by puncture, at least an inch above the joint, and on the inner border, to avoid the ulnar nerve; flexion should not be made for several days, and then gradually.

9. **The pectoralis major** is inserted into the anterior bicipital ridge of the humerus, and tends by its contraction to fix the arm on the front of the chest; it forms the anterior wall of the axillary cavity. In section the tenotome may be passed along its anterior or posterior surface, and if the point is kept in contact with the muscle, division is easily effected without complication.

10. **The deltoid** is inserted into the middle of the outer surface of the shaft of the humerus; its origin is so extensive as to give

it the functions of several muscles. Section may be made of different parts of its insertion according as it may be necessary to relieve contraction; the anterior portion by inserting the tenotome near the insertion from before backwards along its internal surface and cutting to the skin, and the posterior margin by a reverse movement.

11. **The latissimus dorsi and teres major** are inserted into the posterior margin of the bicipital ridge, and form the posterior wall of the axilla: they depress the arm and draw it backwards. Section may be made of the combined muscles by passing the tenotome along either surface, turning its edge to the muscles and dividing with a sawing motion.

TENOTOMY IN THE LOWER LIMBS.

The distortions of the lower limb, due to contractions of the muscular system, form an important part of orthopedy. The different forms of club-foot and hand are due largely to this cause, and are remedied by restoring the balance of muscular forces.

1. **The flexor longus digitorum** affects the toes so as to require division, only when its contraction aids in causing or maintaining other distortions; it lies in such immediate relations with the tibialis posticus behind the malleolus, that if the knife is pushed a little deeper when behind the latter tendon, it will include the tendon of the former muscle, and both may be divided at the same operation; the point of the knife should be moved about as little as possible to avoid wounding the posterior tibial artery.

2. **The flexor longus pollicis** may require section to liberate this part of the foot, so important in every act of walking. It may be divided on the first phalanx,[1] or near the inner edge of the foot, where it can be made to project by strong extension of the toe. The point of division should depend upon the prominence of the tendon; by carefully passing the tenotome along the tendon, the plantar arteries will escape injury.

3. **The extensor longus digitorum** may fix the toes in a state of extension, or, by contraction, may elevate the anterior part of the foot. In the former case, section of separate tendons should be made on the dorsum of the metatarsus where there are neither important arteries nor nerves: the extensor of the great toe often requires section also; the skin may be pinched up and the tenotome passed between it and the tendon, and division made towards the bone. In the latter case section should be made where the tendons pass over the ankle; enter the tenotome close to the inner border of the tendon made tense, pass it outwards, and when the point is at the extremest border turn the edge upwards.

[1] J. Syme.

4. **The extensor proprius pollicis** has upon its internal border below, the anterior tibial vessels and nerves and dorsalis pedis artery. Section may be made through the same puncture as that used for section of the long flexor of the toes, the point of the knife being turned inwards, and carried no farther than the internal border of the tendon to avoid the vessels and nerve. Or, being made tense, the knife may be inserted on its inner margin and passed outwardly.

5. **The tibialis anticus** passes from the annular ligament of the ankle over the internal surface of the tarsus, and is inserted into the inner and under surface of the internal cuneiform bone and base of the metatarsal of the great toe. In talipes varus it is placed very much to the inner side, and passes obliquely downwards across the inner malleolus, inclined backwards towards the internal cuneiform bone, which occupies a lateral position, owing to the altered position of the scaphoid bone. The tendon can generally be easily felt, except in fat infants; it should be divided a little above its insertion as it crosses the ankle joint.

6. **The tibialis posticus** passes through a groove behind the inner malleolus with the tendon of the flexor longus digitorum, but in a separate sheath, then through another sheath over the internal lateral ligament, beneath the calcaneo-scaphoid articulation, and is inserted into the tuberosity of the scaphoid and internal cuneiform bone.[1] The posterior tibial artery lies behind it. In talipes varus the tendon at the point of division, just above the inner malleolus, is relatively more forward than in the healthy foot, and in the second part of its course, between the malleolus and its insertion into the scaphoid, the tendon does not pass beneath the inner malleolus, and then obliquely downwards and forwards to its insertion; but on the contrary, passes directly downwards to the scaphoid bone.[2] If the tendon is normal, divide it half an inch above the inner ankle; the posterior tibial artery lies posteriorly; make a puncture between the artery and tendon, turn the foot outwards, and cut towards the skin; the artery may often be pressed one side by the finger, — by the nail of the left index finger. If the tendon is displaced, as in varus, the following is important: If neither the tendon nor the inner edge of the tibia can be felt, as is commonly the case in fat infants, a puncture made in the inner aspect of the leg exactly midway between the anterior and posterior borders, is a true guide to the position of the tendon at the point of section. Thrust the tenotome or a sharp-pointed knife straight down to the tendon, and open the sheath by a movement of its point; now insert a blunt-pointed knife beneath the tendon, which will at once be so fixed that it cannot be

[1] H. Gray. [2] W. Adams.

moved from side to side if it is between the tendon and bone; make a complete section of it.

7. **The peroneus tertius** is a part of the long extensor, and branches off to be inserted into the base of the fifth metatarsal. Section is readily made when the long extensor is tense by inserting the tenotome on its external margin and passing it inwards; or it may be divided at the same time with the long extensor.

8. **The peroneus longus and brevis** pass through the same groove behind the external malleolus, and are invested by a common fibrous and synovial sheath; the long peroneus then passes across the outer side of the os calcis, in a separate sheath, over the margin of the cuboid, across the foot to the base of the first metatarsal; the short peroneus passes on the outer side of the os calcis to the base of the fifth metatarsal bone. Section of these tendons may be made: (1.) An inch above the base of the external malleolus, the tenotome entering from before backwards between the fibula and the tendons; or, (2.) half an inch in front of the apex of the malleolus, where they may be made prominent and divided by a single puncture; or, (3.) the long tendon could be divided at a point midway between the end of the malleolus and the tubercle of the cuboid, and the short tendon at the external border of the extensor brevis digitorum.

9. **The tendo-Achillis** is about six inches long, commencing about the middle of the leg, and is inserted into the lower part of the tuberosity of the os calcis; it is separated from the deep vessels by a considerable interval; the external saphenous vein runs along its outer side; section is made as follows: Place the patient on his stomach with the foot hanging over the table or bed; an assistant should put the tendon on the stretch by attempting to flex the foot; introduce the tenotomy knife obliquely downward with its flat surface parallel with the tendon, close to its inner or outer edge, as most convenient, when the tendon is prominent; but when the tendon is deep, enter the knife on the fibular side to avoid the possibility of puncturing the posterior tibial artery; carry the knife to the opposite side, depressing the handle to a horizontal direction; now turn the cutting edge towards the tendon and divide it transversely from the internal to its external surface; close the wound with a compress fixed by adhesive strip and bandage. If the foot is immediately restored, it must be retained in position by a proper shoe or by adhesive strips passed around the anterior part of the foot, and fastened to the upper part of the leg. If reduction is to be gradual, these appliances should not be resorted to in three or four days.

10. **The biceps flexor cruris** is inserted into the head of the fibula, and forms the external hamstring; the external popliteal

nerve lies close to its internal border. Place the patient in a prone position, extend the leg firmly, and recognize the tendon; enter the tenotome an inch above the head of the fibula, on its inner border, inclining it at first outwards, until its point passes under the tendon; then depress the handle to the horizontal, and when its point is felt on the opposite side, turn the edge upwards towards the tendon and divide.

11. **The semi-tendinosus, semi-membranosus, gracilis, and sartorius**, form the inner hamstring, and are inserted upon the inner and anterior surface of the tibia; the nerves and vessels of this region lie quite external. The patient being in a prone position, enter the probe-pointed knife close to the outer side of the tense hamstring to avoid the vessels and nerves of the ham, incline it inwards towards the median line of the body as it passes under the muscles, and until its point is felt on the inner side; now depress the handle and divide the structures towards the skin; the section may be limited to the semi-tendinosus and membranosus, or by deeper penetration all the tendons and muscles forming this group may be safely divided.

12. **The quadriceps extensor cruris** is composed of the rectus, vastus externus and internus, and crureus; the tendon is inserted into the tubercle of the tibia through the medium of the patella and the ligamentum patella; a large bursa lies under the conjoined tendons above the patella. Section above the patella is made as follows: pinch up a fold of skin parallel with the ligament; pass the tenotome through to the tendon, but do not penetrate too deeply; carry the blade along the anterior surface under the skin; turn it towards the tendon, and with a sawing motion cut until all resistance ceases; effectually close the wound, and do not attempt flexion until the repair has begun.

13. **The pectineus** is situated at the anterior part of the upper and inner aspect of the thigh, extending from the ilio-pectineal line of the pelvis to the rough line below the trochanter minor; it is an adductor of the thigh and may be divided as follows:[1] While one assistant fixes the pelvis, and a second straightens the contracted thigh, recognize the tense and elevated tendon of the muscle and pass a long blunt tenotome blade under it from the external side, an inch and a half below its origin; with a few passes of the blade the entire muscle is divided towards the skin, or the section may be made from the skin.

14. **The adductor longus** lies on the same plane as the pectineus; it arises by a flat narrow tendon from the angle of junction of the crest with the symphisis, where it may be readily severed. Abduct

[1] F. Stromeyer.

the thigh and make the muscle prominent near its insertion. Pass the tenotome from without downward and inward, until the muscle is passed; then cut with a sawing motion towards the skin until the contracted tissue is divided.

15. **The tensor vaginæ femoris** is a short, flat muscle arising from the anterior part of the outer lip of the crest of the ilium, and from the outer surface of the anterior superior spinous process, and terminates in the fascia lata of the thigh, one fourth down the external aspect of the thigh. It is easily divided by making it tense and passing a tenotome on either border about an inch from its origin, and cutting towards the skin.

16. **The sartorius** arises by tendinous fibres from the anterior superior spinous process of the ilium, and the upper half of the notch below it. Make a section of its tendon thus: An assistant strongly abducts the thigh, which makes the muscle prominent; pass the long blunt tenotome under the muscle on its external border two and a half inches from its origin and cut towards the skin.

TENOTOMY IN THE TRUNK.

Many of the muscles in the region of the back have been divided to relieve curvature of the spine.[1] The first effect of division of contracted muscles, as the latissimus and longissimus dorsi in lateral curvature, was in some cases instantly, apparently, very beneficial.[2] But in no instance has the operation itself produced a cure, its effect being simply to take off, either in part or whole, the power of muscles engaged in maintaining the curvature, and thus placing the spine in a condition to be more easily influenced by mechanical and physiological causes.[2]

1. **The multifidus spinæ** consist of a number of fleshy and tendinous fasciculi which fill up the groove on either side of the spinous processes from the sacrum to the axis. The tension of the deep-seated layer of muscles of the back is weakened by dividing the thickest part of this muscle, as it lies comparatively superficial upon the dorsum of the sacrum opposite the posterior superior spine of the ilium;[3] pinch up the skin so that the fold is parallel with the spine; pass the tenotome upon the surface of the muscle, and cut towards the spine.

2. **The longissimus dorsi and sacro lumbalis** are portions of the erector spinæ; the former is the inner and larger portion, and is inserted into the tips of the transverse processes of the dorsal vertebræ, and into seven to eleven ribs; the latter is the external and smaller portion, and is inserted into the angles of the six lower ribs. The tension of the middle layer of spinal muscles is relieved by di-

[1] Guérin. [2] Report of Committee on Guérin's Practice. [3] R. Hunter.

viding these muscles in the lumbar region near their origin;[1] operate as above.

3. **The latissimus dorsi** covers the lumbar and lower half of the dorsal regions, and is inserted into the bicipital groove of the humerus. The muscle is made tense by elevating the shoulder forcibly, and may be divided as follows:[2] Select a long, strong tenotome; pass the point under the anterior edge of the muscle, nearly opposite the angle of the scapula, and along the under surface; now turn the edge towards the muscle and cut with a short sawing motion, the thumb being pressed upon the tightly drawn band; turn the knife upon its side and withdraw it, closing the wound with the thumb; dress the wound with adhesive plaster and firmly adjusted roller.[2]

4. **The trapezius** has one origin from the superior curved line and protuberance of the occipital bone. In lateral deviations of the head this muscle may become permanently contracted and require division at its cranial origin. The muscle being made tense by carrying the head to the opposite side, enter the tenotome below the occipital protuberance, pass its blade along the external surface of the muscle, then turn its edge to the muscle and divide the contracted tissue.

The sterno-cleido-mastoid muscle has its origin from the upper part of the sternum by a flat tendon, and from the sternal third of the clavicle by fleshy fibres; behind it are the carotid and subclavian arteries, and internal jugular vein. Division of this part of the muscle is necessary in distortion of the head, wryneck or torticollis, when it depends upon unyielding contraction of the sterno-mastoid without caries of the spine. In some cases only the clavicular portion needs to be divided. The operation is perfectly free from danger, if carefully performed, since the muscle stands out well from the vessels below it, which are again separated by a strong membrane.[3] A separate puncture should be made for each portion of the muscle. An assistant should put the head on the stretch so as to render the muscle prominent (Fig. 164), pass a long tenotome closely along the surface of the clavicular fibres about half an inch above the clavicle, turn its edge towards the muscle and divide completely; enter the tenotome in the same manner and divide the sternal origin.

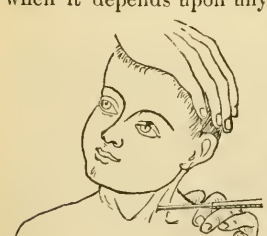


Fig. 164.

[1] R. Hunter. [2] L. A. Sayre. [3] T. Holmes.

IV.

THE CIRCULATORY SYSTEM.

THE HEART; THE ARTERIES; THE CAPILLARIES; THE VEINS; THE LYMPHATICS.

CHAPTER XXI.

THE INJURIES OF THE CIRCULATORY SYSTEM AND SPECIAL OPERATIONS.

I. THE HEART.

Wounds may involve only the pericardium, or they may penetrate to the walls of the heart, or even reach its cavities. The instruments with which they are inflicted are projectiles and pointed bodies, as needles, pins, knives. The symptoms are, hæmorrhage from the wound, more or less free; sudden convulsive movement; pallor; faintness; sighing respiration; cold extremities; small, unequal, and intermitting pulse, and acute pain in the sternal region. Death may be immediate, caused by the sudden arrest of the heart's action, either from shock or the accumulation of blood in the pericardium, or life may be prolonged for days, or complete recovery may follow. The treatment[1] should aim (1) to favor the formation of a coagulum in the wound: close it with antiseptic dressings at once, and do not reopen unless the collection of blood in the pericardium becomes so great as to cause intense dyspnœa and interfere materially with the action of the heart; place the patient in a recumbent position, and enforce the strictest quiet and silence: freely expose the chest to the air, and if there is a tendency to hæmorrhage, apply cold, as ice; remove any foreign body when it can be effected without difficulty, but use no violence in attempting to withdraw it lest fatal hæmorrhage ensue; (2.) prevent the separation of the clot; persistent rest of the body in the recumbent position, and

[1] J. F. West.

removal of all sources of irritation, local or general, must be enforced for a considerable period; venesection is not required, but digitalis to moderate the force of the heart's action, acetate of lead to favor coagulation of the blood, and hypodermic injections of morphia to allay excitement, will be required; interfere with the wound as little as possible; (3) to control inflammation; leeches, perfect rest, low diet, with calomel and opium, are most useful; in all cases a broad flannel bandage applied around the thorax gives the greatest comfort. If the præcordial dullness becomes very extensive from serous effusion into the pericardium, or if still later, there is evidence of a collection of pus, it will be expedient to draw off the fluid with a trocar or aspirator, the cicatrix being the guide to the point of puncture. When a foreign body remains and the diagnosis has been satisfactorily established, extraction by incision has been undertaken with success, as follows:[1] Chloroform being given, a spot was selected at which each impulse of the heart gave the feeling of something firmer than the surrounding tissue; the skin and subcutaneous structures were divided, when the extremity of the needle was brought into view on a level with the surface of the intercostal muscle moving with each impulse of the heart, and describing a curve; the needle was now seized and removed.

II. ARTERIES.

The deep situation of arteries, and their unexposed position at joints, protect them from the more common injuries.

1. **Contusion** may be so slight as to cause but temporary disturbance of the circulation, or so severe as to lead to closure of its calibre, or destruction of its coats. Closure is due to the formation of a thrombus,[2] and is liable to be followed by gangrene of the parts supplied by the artery. If a lesion of the coats finally occurs, a pulsating tumor, traumatic aneurism, forms. The treatment of contusion depends upon its secondary effects; if gangrene follows, amputation will be required when the disease has become limited; if an aneurism appears it must be treated according to the rules established.

2. **Rupture** of the coats of an artery occurs when the limb is subjected to a violent strain. The lesion may involve the internal coat only, or the external coats without lesion of the internal coat, or all of the coats may be torn through. The symptoms depend upon the nature of the lesion; if the internal coat alone is ruptured, there is sudden pain in the part, and the circulation ceases. The artery is finally closed, as in ligature at the point of injury. Lesion of the external coats is followed by pain, and a pulsating tumor, an aneu-

[1] G. W. Callender. [2] R. Moxon.

rism. If all the coats are ruptured, extravasation to a variable extent takes place into the surrounding tissues, with diffused swelling. If the blood is effused in large quantities from a ruptured artery of an extremity, as from the popliteal, which is most frequently injured, gangrene will soon follow. If the extravasation takes place slowly, or to a limited extent, the conditions of an aneurism are gradually developed. The treatment must depend upon the degree of injury to the artery; if blood is effused in small quantities, rest, position, and cold, with pressure upon the distal portion of the trunk, may effect a cure; if there is large effusion, without coldness of the limb below, apply a tourniquet, or the elastic bandage above, cut down upon the ruptured artery, turn out the clot, find the rent, and tie above and below; if the extravasation is excessive, followed by coldness and numbness of the extremity, amputate at once above the seat of injury.

3. **Penetrating** wounds by a small instrument, as a needle, will heal without hæmorrhage or other symptom. If the instrument is large, hæmorrhage may be immediate, or the elasticity of the coats may close the wound temporarily, but it is liable to reopen and bleed. If the wound is incised it may be transverse, oblique, or longitudinal to the axis of the vessel; it may partially or wholly divide the artery; in complete division there is less liability to hæmorrhage than in partial division, owing to the contraction and retraction in the former case; longitudinal incised wounds tend to unite without dressing. The treatment should be as follows: (1.) Remove any foreign body from the wound which might interfere with the closure of the artery; (2.) arrest the hæmorrhage according to the following general rules: —

(*a.*) If the wounded artery is in an extremity, the hæmorrhage may be temporarily controlled, either by strongly flexing, or by very forcibly extending the limb (in the former case the artery is compressed at the bend of the limb, and in the latter compression is made in its course by the muscles and the fasciæ); (*b.*) in all cases of punctured wounds, when pressure can be effectually made, and especially against a bone, it should be tried by graduated compression over the part injured (Fig. 165) and, if necessary, on the artery above and below the wound; if it is in an extremity, bandage the whole limb, the motions of which should be effectually prevented, and absolute rest must be enjoined, especially if the artery is large; continue this treatment for two, three, or more weeks, according to the nature of the injury; (*c.*) if the artery is small, like the temporal, divide the vessel, when it will be enabled to retract and contract; and the bleeding will in general permanently cease under pressure, especially when it can be applied against the bone. If the artery is of a larger class, and continues to bleed, it should be sufficiently exposed by enlarging the wound; a ligature should be applied above and below the opening

Fig. 165.

in the vessel, which may or may not be divided between them. If it is determined to apply a ligature, it is a rule that no operation is to be done for a wounded artery in the first instance but at the spot injured, unless such operation not only appears to be, but is impracticable. No operation should be performed if bleeding has ceased, unless its repetition would endanger life.[1]

Wounds of certain arteries require special treatment, as follows: —

1. In the neck. (1) When the internal carotid is wounded through the mouth, place a ligature above and below the opening made into it;[2] the rule which generally obtains among surgeons is to apply a ligature to the common carotid; (2) when any one of the branches of the external carotid has been wounded, tie both ends at the part wounded; if this is impracticable, and the hæmorrhage demands it, the trunk of the external carotid should be ligated, not the common carotid; (3) the internal carotid artery, when wounded near the bifurcation of the common carotid, is to be secured by two ligatures; (4) a ligature may be placed on the internal or external carotid, close to the bifurcation, with safety; but if the wound of either vessel should encroach on the bifurcation, one ligature should be applied on the common trunk, and another above the part wounded; but as neither of these would control the collateral circulation through the uninjured vessel, whichever of the two it might be, a third ligature should be placed on it above the bifurcation; (5) a wound known or suspected to be of the vertebral artery should be treated either by direct pressure or by ligature of the vessel in the wound[3]; (6) never place a ligature on the subclavian artery above the clavicle for a wound of the axillary below it.

1. In the upper limb. (1) In punctured wounds of the arteries of the arm and forearm apply pressure to the part injured, and a bandage to the limb generally; but when the bleeding cannot be restrained in this manner, a ligature should be applied above and below at the part injured whether the artery be radial, ulnar, or interosseal; (2) when the ulnar artery is wounded in the hand, which is comparatively a superficial vessel, pressure may first be tried; but failing, apply ligatures upon each extremity; (3) when the radial artery is wounded in the hand, in which situation it is deep seated, and the bleeding end or ends of the artery can be seen, place a ligature on each; if this cannot be done, search by incisions through the fascia, as extensively as the situation of the tendons and nerves in the hand will permit, that the bleeding point may be fully exposed, remove all coagula, lay a piece of lint, rolled tight and hard, of a size only sufficient to cover the bleeding point, upon it; place a second and larger hard piece over it, and so on, until the compresses rise so much above the level of the wound as to allow the pressure to be continued and retained on the proper spot, without including the neighboring parts; apply a piece of linen, constantly wet and cold, over the sides of the wound, which should not be closed, to allow of the free escape of blood. It is desirable to ligate the brachial artery rather than the radial and ulnar in secondary hæmorrhage of hand.[1]

3. In the lower limb. (1) The anterior tibial artery is to be tied at that part of its course at which it may be wounded; if the wound is very near its origin, or just behind the interosseous space and ligament, and the bleeding free, make an incision on the fore part of the leg, and if the bleeding point is so deep between the bones as not to admit of two ligatures being placed on the artery above and below it, make an incision through the calf of the leg, when the artery can be secured without difficulty; (2) the posterior tibial, or the peroneal

[1] C. F. Maunder. [2] C. J. Guthrie. [3] T. Holmes.

artery, or both, if wounded at the same time, are to be tied through a free incision in the calf; (3) the popliteal artery should be secured by ligature, only when bleeding; (4) when a wound of the femoral artery or its branches occurs, and the bleeding cannot be restrained by a moderate but regulated compression on the trunk of the vessel, and perhaps on the injured part, recourse should be had to an operation, by which both ends of the wounded artery may be secured by ligature; and the impracticability of doing this should be ascertained only by the failure of the attempt; if the lower end of the artery cannot be found at the time, the upper only having bled, a gentle compression maintained upon the track of the lower may prevent mischief; but if dark-colored blood should flow from the wound, which may be expected to come from the lower end of the artery, and compression does not suffice to suppress the hæmorrhage, the bleeding end of the vessel must be exposed, and secured near to its extremity; (5.) wounds of the branches of the internal iliac require that a ligature should be applied to both cut extremities, and not to the arteries at their origin.

III. THE VEINS.

The veins are liable to traumatic lesions, but owing to the quiet flow of the blood-current, and the compression of surrounding tissues, the effusion is rarely serious. When, however, injuries of deep-seated veins, especially those communicating with cavities, occur, the hæmorrhage may be dangerous.

1. **Contusion**[1] causes the rupture of a greater or less number of superficial veins, followed by the extravasation of blood into the surrounding tissues, or into cavities. The more vascular and yielding a part, and the more severely contused, the greater the extravasation; if the blood escapes slowly it forms a passage-way between the connective-tissue bundles, especially subcutaneous connective-tissue and muscles, the wounds being rough and ragged, obstacles are presented to the free escape of blood, and fibrinous clots form, extending into the calibre of the vessel, causing mechanical closure by thromboses. The escaped blood undergoes various changes, namely: the fibrine coagulates, the serum enters the connective tissue and is re-absorbed, the coloring matter leaves the blood-corpuscles and is distributed in solution among the tissues, passing through various metamorphoses, with change of color till it is transformed into hematoidin; the fibrine and blood corpuscles for the most part undergo disorganization and are re-absorbed. The effused blood assumes different conditions: (1.) Suggillation is a diffuse, subcutaneous hæmorrhage, of a dark blue color, which changes into a green, and then into a brighty ellow, which remains for a long period. Re-absorption usually takes place, owing to the diffusion of the blood, and the good condition of the vessels; apply cold to prevent further extravasation, and spirit or stimulating lotions to promote absorption. (2.) Ecchymosis is the accumulation of blood into a circumscribed

[1] T. Billroth.

space of connective tissues, and may be superficial with a dark blue color, or deep without discoloration; fluctuation is often very distinct. The blood will have the same fate as the contused tissues; if they return to their normal state, re-absorption will follow; but if they are broken down and pass into disintegration or decomposition, the blood collection will undergo the same change. Immediately after the accident apply compression as accurately as possible to the ruptured vessel to prevent further effusion; apply ice, or cold lotions, to prevent inflammation; employ uniform compression, with moist dressings to promote absorption; if there is no marked change in two weeks, to compression add painting with tr. iodine daily; if it become hot, red, and painful, apply warm, moist dressings, as poultices, and wait for thinning of the skin over the forming abscess before opening it; if the tension and swelling rapidly increase, with chills and fever, the blood and pus are decomposing, and the contents must be evacuated by free incision, and the cavity cleansed and dressed with carbolic solution.

2. **Wounds** of veins are of frequent occurrence, and generally of slight importance. They are recognized by the flow of dark blood without jet or impulse. They heal readily, owing to the easy approximation of the cut surfaces, and the prompt formation of the blood clot in the wound and vessel. The danger is three-fold, namely, hæmorrhage; the entrance of air; inflammation in the connective tissue with the formation of thrombus. Ligate the vein, if exposed and accessible, or use torsion or acupressure; elevate the limb or part, and remove all constriction above the wound; apply firm compression over the wound; prevent inflammation by the use of cold.

V. THE LYMPHATICS.

Wounds[1] of the lymphatic vessels occur in every considerable wound of the soft tissues, but their injury is concealed by the flow of blood, and the lesions of other vessels. It is only by the subsequent inflammation that their lesions become important. From the margins of the wound fine red striæ run longitudinally towards the glands, which swell and become very sensitive, accompanied by fever, loss of appetite, and general depression. The inflammation may terminate in resolution, or the limb may become red and œdematous, with high fever, and even chills, and fluctuation soon after announces the formation of pus in the glands or cellular tissue. The early treatment should be cleansing and disinfection of the wound to prevent the further absorption of septic fluids; rest; active purgation; local applications of lead and opium lotions, or inunctions of mercurial ointment; wrapping the limb in cotton, the limb mean-

[1] C. H. Moore; T. Billroth.

time being elevated and wrapped so as to maintain an even temperature. If pus forms it must be evacuated early; if it is in a gland, and healing does not progress satisfactorily, use hot, moist applications, lest the poison again extend from the gland.

VI. ARTERY AND VEIN.

Wounds may penetrate an artery and adjacent vein, or the lesion of the two vessels may occur spontaneously, and lead to an admixture of the two currents, creating a form of aneurism.

Arterio-venous aneurism is described as of two kinds: (1) Aneurismal varix, when the two vessels are so united at the seat of lesion that the arterial current passes directly into the vein without the intervention of a sac (Fig. 166); (2) varicose aneurism, when there is a sac interposed between the artery and vein (Fig. 167). The symptoms are well defined; the vein pulsates, enlarges, becomes tortuous, and has a fusiform shape; there is often a harsh rasping sound on the proximal side; the mass is soft and compressible. The tendency of the tumor is to an arrest of growth. At an early period it may often be cured by pressure simultaneously made on the main artery and on the orifice of communication by two persons, one pressing lightly on the point at which the arterial stream enters the tumor, with sufficient force to suspend the cooing murmur, the other compressing the artery at some convenient spot above the tumor.[1] If the tumor enlarges and radical treatment is necessary, the ligature should be applied to the vessels at the seat of lesion.[2] An anæsthetic being given, apply the elastic bandage to the limb; make a long and free incision over the tumor; lay open the sac to its full extent, and remove the blood; pass a probe through the orifice into the sac and lay it open; now find the opening into the artery, and apply a ligature to that vessel above and below the lesion;[3] the artery may be tied outside of the sac in small tumors; if necessary, the vein may also be ligated.[3] Both the artery and vein have been successfully tied above and below the tumor.[4]

Fig. 166.

Fig. 167.

[1] T. Holmes. [2] W. H. Van Buren. [3] F. H. Hamilton. [4] T. Annandale.

CHAPTER XXII.

DISEASES OF THE CIRCULATORY SYSTEM AND SPECIAL OPERATIONS.

I. THE HEART.

1. **Inflammation** of the serous pericardium, if of traumatic origin, may result in the formation of pus in its cavity, or, if idiopathic, may terminate in an accumulation of serum. Whatever may be the nature of the distending fluid, if it leads to great embarrassment of the heart's action and the respiration, and all the usual remedies have failed to give relief, removal by the aspirator or trocar and canula may with proper precautions be undertaken.

II. THE ARTERIES.

1. **Arterial thrombosis** is the formation of blood-clot, or thrombus, in an artery, and is caused by retardation of the blood-current, or irregularities on the inner wall of the vessel, which increase the friction between it and the passing blood; they are laminated when formed by an intermittent, gradual, and long-continued coagulation, as in aneurism, and non-laminated when they originate in sudden coagulation of an isolated mass of blood, as after ligature of an artery. The clot may organize and become a member of the series of vascular connective tissues, or it may soften, giving rise to abscess or embolism.[1]

2. **Cirsoid aneurism** is the dilatation and lengthening of an artery, giving it the appearance of varicosity; it may appear over the occiput, vertex, temples, or in the extremities; it usually lies just under the skin, and is readily recognized by the tortuous pulsating artery or arteries.[2] The treatment should be directed to the prevention of the further enlargement of the artery by elevating the part as much as possible, douches of cold water followed by supporting appliances, as elastic bandages, laced stockings when the lower extremity is affected. When the tumor is inconvenient, or from other causes it is necessary to undertake a radical cure, the ligature of the trunk artery leading to it, though an exceedingly uncertain measure, is perhaps the best, the dilated vessel itself being too much altered in structure to bear the ligature with safety.[3]

3. **Aneurism by anastomosis** differs from the preceding only in

[1] E. Rindfleisch. [2] T. Billroth. [3] T. Holmes.

the larger number of arteries involved and the final implication of capillaries and veins. They are large, irregular, lobulated, pulsating masses, in which a considerable bruit can often be heard, and numerous large vessels can be traced into them on all sides; the capillaries share in the enlargement, and the veins thus receive the pulsation; as the arteries enlarge, their coats become thin, so that it is impossible to distinguish between the arteries and veins around the tumor; their favorite seats are the scalp near the ear and the lip.[1] Excise the mass, if small and favorably situated, as on the lip, cutting wide of the growth;[2] apply the ligature subcutaneously, as in nævus, when the tissues admit; apply a ligature to the trunk of the main artery when the growth is favorably located, as to the external carotid when the disease is in the temporal artery, to the common carotid when the orbit is the seat of the disease; electro-puncture should be employed in severe cases, especially when deeply situated;[3] coagulating agents, as perchloride of iron, may be injected, care being taken to prevent the escape of coagula by accurate pressure around the growth; amputate when the disease affects seriously the bones of the extremity.

4. **Atheroma**[4] consists in a chronic inflammation of the inner coat of the artery; the predisposing causes are advanced age, alcoholic stimulants, gouty diathesis, and the localizing cause, mechanical irritation of the impact of the blood on points of curvature and bifurcation of the artery; the change consists in a thickening of the membrane itself, a proliferation in and from the connective tissue of the intima, causing an increase of its bulk, and culminating in an inflammatory overgrowth. Retrograde tissue-metamorphosis now begins, which may terminate in fatty degenerations of the cells, combined with solution of the intercellular substance, and the formation of an atheromatous abscess; or the intercellular substance may become impregnated with earthy salts, a calcification, and form plates of variable size and form. The result of these changes is diminution of the calibre of the vessel, which leads to diminished force of the circulation beyond the lesion, and increased force on the proximal side. Two effects may follow: (1) lessened nutrition, and even gangrene of the extremity supplied by the obstructed artery; or, (2) yielding of the vessel, causing aneurism. The treatment is limited to the effects of the disease. If gangrene occur, amputation must be performed only when the line of demarcation is well established; if the operation is undertaken too early, reamputation may be required, owing to the extension of the disease. Aneurism requires special treatment.

5. **Aneurism** occurs when the coats of an artery, weakened by

[1] T. Holmes. [2] Heine. [3] J. Spence. [4] E. Rindfleisch; R. Moxon.

atheroma or calcification, yield at the point of greatest pressure of the blood-current, and give rise to a tumor. The shape and size which it assumes depend upon the number of coats involved, the location of the lesion, and the surrounding tissues. It may be invested by all of the coats of the artery, by one or more coats, or the coats may have all ruptured, and the investing capsule may be the connective tissue; or, finally, the blood may be extravasated among the tissues, due to the rupture of the coats from atheroma, or overstrain, and generally at arterial curves or subdivisions. The diagnostic signs are: (1) A tumor in the course of an artery; (2) expansive pulsation, synchronous with the heart; (3) a bruit; (4) cessation of pulsation and diminution of tumor on compressing the artery on the proximal side. There are many sources of error in these signs, and hence they must be carefully studied as a group; if doubt remains, puncture with a hypodermic syringe, or the needle of an aspirator, and examine the contents.

The various methods of treatment aim at the consolidation of the blood in the tumor, and obliteration by absorption or organization of its contents. This may be effected by operations upon the tumor and upon the arteries. The operations upon the tumor are designed to diminish the force of the circulation, or interrupt it altogether, in order to effect coagulation of its fluid contents.

1. **Manipulation** [1] is practiced to displace a clot which, escaping from the cavity into the artery, is carried to a lower point where it lodges, and plugs the artery, and leads to a set-back and interruption of the current through the aneurism. It has been successfully employed in popliteal, femoral, carotid, and subclavian aneurism, and is, undoubtedly, a justifiable measure in tumors which cannot be operated on without very great danger, and are not near to bursting, and in which there is evidence of blood-clot.[2] Fatal results have followed this operation when practiced on aneurisms of the neck from embolism of the brain.[3] Place the flat end of the thumb on the prominence of the tumor, and press until the fluid contents escape, and the upper surface of the aneurism is pressed against the lower; now give a rubbing motion to the thumb so as to cause a friction of surfaces within the flattened mass.

2. **Injection of coagulation agents** has proved successful; but as this method is always liable to cause dangerous inflammation, gangrene, embolism, it is not justifiable where compression can be used.[4] The agent preferred is a neutral solution of perchloride of iron, twenty minims strength.[5] Compress the artery above and below the tumor so as to completely arrest the circulation; introduce the needle of the hypodermic syringe perpendicularly to the tumor until the extremity is within the cavity of the aneurism, as will appear by the escape of arterial blood; the canula, containing fifteen to twenty drops of the fluid, is screwed on to the needle; now inject drop by drop, occasionally changing the position of the extremity of the needle to form new centres of coagulation; when the tumor has become sufficiently firm, draw the piston to suck up any

[1] Sir W. Fergusson. [2] T. Holmes. [3] F. Esmarch.
[4] Marsacci. [5] Valletta.

free acid which would irritate the soft tissues, and carefully withdraw the instrument; continue compression on the cardiac side for an hour or more.

3. **The elastic bandage** has been successfully employed, the object being to completely control the circulation of the limb and tumor for a time. Apply the elastic bandage from the extremity upward above the tumor, but lightly over the aneurism; apply the elastic tubing around the limb over the highest turn of the bandage, and remove the bandage; the limb is now pallid and the tumor pulseless; after fifty minutes, apply compression to the main trunk, and remove the tubing; continue pressure, if necessary, in an intermittent manner for a day or two, when the cure will be found complete.[1]

4. **Flexion**[2] has been successful in aneurism at the bend of the elbow, knee, and hip, and is indicated in small aneurisms, so situated that the pulsation and bruit are suspended by bending the joint: it need not be extreme nor painful, nor need the limb be bandaged or confined in any way in many cases, as voluntary flexion, the patient being allowed to change the position of the limb slightly, will sometimes succeed when forced flexion would not be tolerated; as flexion acts by retarding the blood-stream and displacing clot, pressure may be combined in the treatment; forced flexion may cause rupture of the sac.[3] Bandage the limb from the extremity nearly to the joint, then flex the limb firmly and turn the roller around the part above, thus fixing the forearm or leg in a flexed position.

5. **Foreign bodies** have been introduced into the cavity of the aneurism for the purpose of inducing coagulation by whipping the blood; the cases selected were most unfavorable, and all were fatal, but not from the effect of the operation. Iron wire,[4] horse hair,[5] carbolized catgut,[6] are the agents which have been used; they were introduced through a fine canula.

6. **Electrolysis** is designed to secure a gradual deposit of the layers of fibrin, and has proved successful in forty-eight out of ninety cases,[7] for the most part of the extremities; abdominal and thoracic aneurisms have rarely been benefited; in the latter case, if the disease tends certainly to death and other methods have failed, electro-puncture would be justified.[8] Give an anæsthetic; begin with one or two cells; introduce into the aneurism two or three needles connected with the negative pole, while a sponge electrode connected with the positive pole is applied to the adjacent surface; the length of the application may be five to forty-five minutes; from one to four or five operations are usually sufficient.[9]

Operations upon the arteries are performed for the purpose of arresting the flow of blood into the aneurism, and thus promoting coagulation.

1. **Ligation** of the arterial trunk has long been the approved method of obstructing the circulation in an aneurism. The ligature has generally been some irritating, indestructible material, as silk, which, in its application, ruptured the internal coats, and then by slow degrees divided the external coat, and was cast off from the wound. The cure of the divided artery was effected by the organization of a clot, and the final repair of the cut ends; but this process is always liable to be interrupted; the clot may not organize and the cut ends of the artery may not repair, owing to the inflammation which the ligature creates. This result is followed by hæmorrhage from the wound, always a dangerous

[1] W. Reid. [2] E. Hart. [3] T. Holmes. [4] C. H. Moore. [5] R. J. Levis. [6] Murray. [7] A. M. Hamilton. [8] H. I. Bowditch. [9] Beard & Rockwell.

complication. These dangers are very materially diminished by the use of an unirritating ligature, as silver or iron wire, which may remain long in the wound without causing inflammation. But the most perfect results are obtained when an unirritating and absorbable ligature is used, as carbolized catgut. The ligature need not be so tightly applied as to sever the coats of the artery, and the wound may at once be permanently closed. The course of repair consists in the union of the external wound without suppuration, the union of the opposed surfaces of the internal coat of the artery, the replacement of the old ligature by a new ligature of living tissue which strengthens the artery at the point of ligation. It follows that such a ligature may be applied where silk would ordinarily prove fatal, as in the vicinity of large trunks, and where a resulting inflammation would dangerously complicate the operation, as in proximity with serous cavities. The only defect in the method of applying absorbable ligatures is the liability of their absorption before the cure is completed; but this has been remedied by preparing the catgut so that it will remain firmly applied for a sufficiently long time and then undergo absorption without irritation. The rule, therefore, should be to select a ligature which is unirritating, and will be absorbed, and to apply it with antiseptic dressings. But if such a ligature is not at hand, the silk should be carbolized, and applied antiseptically. The several points of ligation are as follows: (1) On the cardiac side, near the tumor,[1] or near the first collateral branch, above the aneurism;[2] the latter point is always to be preferred when the artery is readily accessible, as the femoral, for popliteal aneurism; (2) on the distal side[3] when the artery cannot safely be reached on the cardiac side, as the subclavian or common carotid in innominate aneurism; (3) At its entrance into, and exit from, the aneurism, the old operation,[4] as in carotid aneurism at the base of the neck, or traumatic aneurisms.

2. **Compression** consists in the application of pressure to the artery, on the cardiac side, with a view to cause stagnation of a mass of blood in the aneurism until it coagulates. This method is capable of curing the majority of surgical aneurisms, and when it fails, in no marked manner militates against the adoption of other measures.[5] Pressure may be digital or instrumental; the former, when successful, is more rapid and less painful, and should be preferred if all the conditions are favorable. To be successful, pressure must be regular, efficient, and equable.[6]

Commence the treatment by preparing the patient with several days of rest and low diet to reduce the circulation; select three or four reliable assistants, who must be employed for four or five hours consecutively, each in rotation applying pressure for ten minutes at a time; the pressure must be steady and equal by the finger or thumb placed directly over the vessel, with just sufficient force to arrest the flow of blood and no more;[5] if the patient becomes restive, give anodynes; or it may be necessary to intermit to give the patient rest. The pressure of the fingers may be reinforced by placing a weight, as a bag of shot, upon the ends. The cure may be very rapid, even occurring in one and a half, two and a half, and three hours,[7] or it may be prolonged; pressure should not be given up unless after several days no impression is made, or the surface ulcerates. Instrumental compression may be made in a variety of ways, but in all cases the point used for pressure should, as far as possible, be small, like the finger ends, in order to make accurate pressure on the artery and avoid compression of the vein. A simple appliance is a bag

[1] Anel. [2] J. Hunter. [3] Brasdor. [4] J. Syme. [5] T. Bryant.
[6] T. Holmes. [7] J. Knight.

sac of sand or small shot, made tapering at one end, and suspended by an elastic band; tourniquet pads may be adapted to various forms of apparatus so as to make pressure at a single point (Fig. 168), or at several points allowing intermittent pressure.

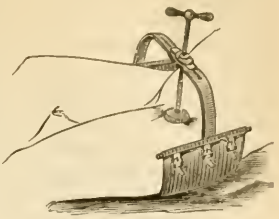


Fig. 168.

3. **Acupressure** can be practiced with safety upon arteries which are so much diseased that they are too brittle and friable to bear the strain of a ligature; in cases of aneurism where the artery is diseased for some distance above the sack, the vessel may be closed by an acupressure-needle at a point where it would be inexpedient to apply a ligature; thus, an aneurism of the lower femoral may be treated by acupressure at the upper portion of the femoral, whereas, if treated by deligation, the ligature would have to be placed upon the external iliac artery, a much more serious operation.[1] Pass the needle under the artery and make a figure of 8 with the thread.

4. **Constriction**[2] is made by the artery constrictor (Fig. 169); expose the artery at the point for constriction, and apply the constrictor (Fig. 170) as directed (p. 25); the internal coats being ruptured, remove the instrument and accurately close the wound; a clot forms, the current of blood is permanently interrupted, and the consolidation of the aneurism takes place.

Fig. 169.

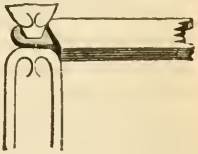


Fig. 170.

III. THE VEINS.

1. **Venous thrombosis** is due to the same conditions which cause thrombus of an artery, namely, retardation of the circulation, or irregularities in the coats of the vessels. More frequently they are caused by acute inflammation of cellular tissues, especially under fascia, tense skin, or bone.[3] The thrombus forming at one point often extends by the deposition of fibrin to other branches until a large number, or a plexus of veins, is filled. The clot may be reabsorbed, or organized into connective tissue, or suppurate, forming an abscess, or undergo disintegration, giving rise to embolism.[3] The treatment is absolute rest, with applications of ice; friction with mercurial ointment to prevent embolism; early evacuation of purulent collections.[3]

2. **Varices** are veins in a state of permanent dilatation. Veins in certain localities, as in the plexuses of the true pelvis and its outlet,

[1] J. C. Hutchison. [2] S. F. Spier. [3] T. Billroth.

and in the superficies of the leg, undergo permanent dilatation, causing varix, phlebectasy. This change is the result of a local rise in the blood-pressure; the disorder is never restricted to a single and very marked dilatation of a vein, but always involves the moderate dilatation of an entire plexus, or of all of the branches of a single trunk; the distention begins just above the valves, which, having to support a greater weight than usual, become incompetent, and the vein is stretched longitudinally; the fixed condition of both ends of the vein compels the elongated vessel to bend, forming zigzags, or become spirally twisted.[1] The tendency to varices is individual, or inherited; hence the ordinary causes act upon existing predispositions.[2] Dilatation may affect alike both the superficial and deep veins;[3] in the former case the disease is apparent, in the latter it is recognized by the enlargement of parts, the unusual weight, aching, and sense of weariness. In general, varices are merely causes of discomfort and inconvenience; but they may create disabilities so serious as to necessitate operations designed for their radical cure. The general plan of treatment is as follows: Remove the causes of local blood-pressure; support the distended veins and restore their tonicity; operate only upon such varices as cause serious inconvenience or permanently disable the patient. The special treatment must vary with the particular class of veins affected, their condition, and the causes which created and maintain the varicose state.

The veins which more frequently become varicose and require radical treatment by operations are as follows: —

1. **The internal saphena vein, varicose**, forms soft nodular masses, or tortuous elevations of the skin on the anterior and inner aspect of the leg; the disease may involve a few branches or the entire plexus and the trunk above the knee. It occurs more often in persons who stand much; in women who have borne many children; and in those who have undue pressure upon some part of the main trunk. Palliative treatment, in the form of the elastic stocking, can be most satisfactorily employed. Operations are very rarely required; those most approved are as follows: (1) Acupressure; raise the vein so as not to puncture it, pass two pins under it an inch apart, and twist a figure-of-8 silk ligature around the pins, or use India-rubber, or wire; now pass a tenotome under the included vein and divide it subcutaneously; support the limb with a bandage; remove the pins in three to five days; excision should be delayed several days;[4] (2) injections of coagulating fluids; use persulphate of iron with hypodermic syringe thus: apply a compress and roller on the vein above, the patient first standing until the vein is well dis-

[1] E. Rindfleisch. [2] T. Billroth. [3] Verneuil. [4] H. Lee.

tended; fill the syringe and then force out a drop or two to expel the air, pointing upwards; select several of the most prominent nodules and inject into each three or four drops; apply adhesive plaster over the punctures; retain the compress over the vein two or three days and enjoin perfect rest.

2. **The hæmorrhoidal veins, varicose,** constitute hæmorrhoids; they have their origin in congestion of the venous radicals in the lax submucous tissue of the rectum close to the anus: mucous catarrh and overgrowth of the mucous follicles follow; at a later stage the phlebectasy proceeds to the development of large plexuses of varicose veins which push the mucous membrane before them and form a ring of transverse rugæ round the anal aperture; the dilatation finally concentrates at one or more points of these rugæ, which develop into rounded protuberances, and ultimately into fungoid tumors of considerable size; the chief part of the texture of a hæmorrhoid is spongy, being atrophied connective tissue, caused by the pressure of the distended veins kept up by the persistently increased tension in their interior; inflammation often occurs about these venous plexuses, resulting in induration or suppuration, and blood may coagulate in their interior.[1] Veins may rupture into the connective tissue around the anus, and by subsequent inflammation and condensation of connective tissue give rise to tumors of various size, color, and density, external piles. In general, patients complain of fullness and weight in the rectum, pain in the loins and thighs, bleeding after defecation. Every case should be thoroughly examined before the plan of treatment is settled. Place the patient on the side, on the edge of a sofa, with the knees drawn up; separate the nates gently; external piles will appear as tabs, or bluish more or less inflamed masses covered by skin; internal piles may protrude from the anus as large grape-like tumors, often very sensitive, or, if not protruding, the finger well-oiled, introduced into the rectum, will detect the growths.

In early stages hæmorrhoids may be cured by the removal of those conditions which cause congestion of the veins of the rectum, and the free use of cold water to the anus when the bowels move. If the piles are inflamed, direct rest in the recumbent position; hot or cold applications, as may be most agreeable; mild cathartics, as the following: mag. sulphate, mag. carb., sulphuris precipitati, saech. lactis, āā ℥ss.; pulv. anisi, ℥ii.; M.; take one or two teaspoonfuls at bed-time.[2] If external piles suppurate, apply anodyne poultices; when the inflammation subsides use astringents, as lead water, oint. nut-galls. If internal piles become prolapsed and painful, with fingers well oiled, or with a cloth wet with cold water, reduce them by

[1] E. Rindfleisch. [2] G. T. Elliot.

gentle pressure, the patient reclining with the hips raised, or resting on his knees and elbows.

External piles should be removed by excision: place the patient on the side with the thighs flexed; subdue sensation by local anæsthesia; seize the pile with firm forceps and excise with curved scissors by incisions radiating from the anus. Internal piles may be removed by ligature or cautery. Strangulation by the ligature is the safest, surest, and most manageable procedure;[1] give a full dose of castor oil twelve hours before the operation; secure the protrusion of the piles as far as possible by the efforts of the patient, after an enema of warm water, straining over a vessel containing hot water; place the patient on the side and separate widely the buttocks; if an anæsthetic is used, the position with the upper part of the body prone, the hips elevated, and the thighs flexed on the abdomen is preferable, and in this case commence the operation by forcible dilatation of the sphincter ani, by which the interior of the lower part of the rectum is fully exposed.[1] Seize the tumor with forceps or a tenaculum; avoid the skin or make a light incision around its base where the covering is integument; transfix with a curved needle armed with a double ligature of stout silk (Fig. 170); divide the ligature at the eye of the needle and tie each half around its portion of the tumor with such firmness as to thoroughly strangulate the part (Fig. 171); cut off the ends of the ligature and half of the protruding mass of the tumor, if it is very large; ligate all the hæmorrhoidal tumors in the same manner, and return the mass within the sphincter.

Fig. 170.

Fig. 171.

The cautery, galvanic or iron, is preferred by many surgeons; prepare the patient as for ligation; on seizing the pile with forceps apply a clamp (Fig. 172) on its base; the blades of the clamp, the surfaces of which are faced with ivory to prevent the communication of heat to sensitive parts, close perfectly parallel by means of a screw so as to compress the mass equally; cut off with scissors half of each mass, dry the surface, and apply the cautery at a white heat until the remaining portion is burned to an eschar down to the clamp; remove the clamp carefully, and with well-oiled fingers return the eschars within the sphincter; apply cold to prevent inflammation and give opiate suppositories or morphine to relieve pain and quiet the bowels; confine the patient to bed with a light diet; at the end of four or five days move the bowels with oil.

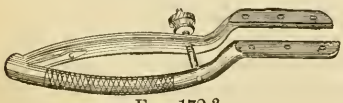


Fig. 172.[2]

[1] W. H. Van Buren.

[2] H. Smith.

If the tumor is small, sessile, strawberry-like in appearance, frequently emitting bright red blood, it is composed largely of congested mucous membrane, and may be treated with nitric acid. Prepare the patient as for ligature; while the hæmorrhoid is protruded, wipe the surface with lint and touch it with the end of a flat piece of wood dipped in nitric acid; smear the parts well with oil, and return the whole within the anus. It is not necessary to confine the patient to bed; if hæmorrhage occur, examine the part, and apply a styptic to the bleeding surface.

3. **The urethral veins** of the female become varicose, and appear as small vascular tumors of the meatus urinarius;[1] they may be single or multiple, pedunculated or sessile; their most frequent site is the floor of the meatus at its extremity, but they may extend deeply. The more marked symptoms are proneness to bleed, great sensitiveness, liability to become extruded and inflamed, pain during micturition. An examination, which should always be made when a patient complains of pain in urination, with occasional bleeding, reveals the nature of the disease. The ligature and caustic are the only effective agents. Administer an anæsthetic and place the patient in the position for lithotomy; if the ligature is used, transfix the mass from behind forwards with a fine tenaculum and apply the thread beneath the instrument so as to inclose the base of the tumor; if caustic is preferred, it must be boldly used; the actual cautery, especially the galvanic, is most manageable. Chromic acid may be used as follows: surround the growths with cotton wool soaked in solution of carbonate of soda; make a swab of cotton wool on a stick, with which apply the acid solution; repeat in five or six days.[2]

4. **The spermatic veins**, when varicose, constitute varicocele; these veins are subject to turgescence, the chief factor in its production being ungratified sexual desire, or abuse of the sexual organs, by which the veins are kept constantly engorged;[3] dilatation, serious enough to constitute a disease, is an exaggeration of this condition; it occurs in early manhood, on the left side, rarely on the right; the vessels are elongated, the valves broken down, and the walls thickened and affected with fatty atrophy; the mass fills up one side of the scrotum, is of a pyriform shape, and has the feeling of a bunch of earth worms; in the recumbent position the tumor disappears, proving that it is not hydrocele, and if a finger is pressed on the external ring, when the patient rises, the tumor will return, showing that it is not hernia. The slighter grades are cured by the removal of the conditions inducing congestion of the veins, and the free use of cold water; the severe forms may be palliated by the use of the

[1] J. Hutchinson. [2] A. W. Ellis. [3] Van Buren and Keyes.

suspension apparatus, and a compress or truss so placed over the external ring as to prevent the distention of the veins by exertion. As all procedures for the radical cure are more or less dangerous, an operation should be undertaken only in those cases where the patient is kept in a state of constant unrest, and worried into bad health by morbidly dwelling on his troubles; or, in neuralgia with liability to atrophy of testicle, or when the suspensory bandage fails, or the patient is not satisfied with it.[1] When operative procedures are required two methods are advocated: (1.) Excision of the scrotum is regarded as the only method which offers a fair prospect of relief without serious accompanying risks; it is curative only in the sense of preventing further disease, arresting atrophy of the testis, and usually relieving pain, and the result is nearly uniformly satisfactory.[1] Place the patient in the recumbent position, the testis being raised to the external ring by an assistant; draw a sufficient portion of the relaxed scrotum between the fingers; excise with the knife or large scissors and tie all bleeding arteries; bring the edges of the incised skin together by raising the lower portion towards the upper, and apply the requisite number of sutures.[2] (2.) Obliteration of the large veins by subcutaneous ligature is as follows :[3] —

(*a.*) With the left thumb and index-finger separate the vas deferens, which feels hard and cordlike, from the veins; carry a needle armed with a double ligature behind the veins and leave it in place; now drop the veins and grasp only the skin and through the same orifices, but in the reverse direction, carry a second loop in front of the veins; the bundle of veins (Fig. 173) is included between the two loops; pass the free extremities of each thread through the loops of the other, and tighten them (Fig. 174), thus effectually strangulating the veins under the skin; fasten the extremities by tying over a small roll or compress. Subcutaneous section may be performed as follows:[4]

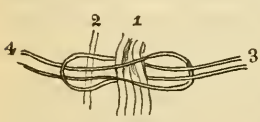


Fig. 173.

Fig. 174.

(*b.*) Pass a needle between the vas deferens and the veins at two points, separated one inch, apply a ligature over each needle sufficiently firm to stop all circulation in the veins; two days after divide subcutaneously the veins which feel like soft cords between the two pins; two days later withdraw the pins; within the next three or four days the cure will be complete by the consolidation of the veins.

5. **Venous nævi**, cavernous angiomata,[5] consist chiefly of dis-

[1] Van Buren and Keyes. [2] Sir A. Cooper. [3] M. Ricord.
[4] H. Lee. [5] T. Billroth.

tended veins, in a white, firm, tough network, having an indistinct boundary; or a sort of capsule; these tumors are rarely congenital, but generally appear in childhood or youth; their seat is chiefly in the subcutaneous cellular tissue, more frequently in the face; they often occur in large numbers, but in such a way that a certain vascular district is to be regarded as the seat of disease, as the face, arm, foot, or leg; they cause weakness of muscles, some pain, and disfigurement; they may attain considerable size and prove dangerous, especially by their destruction of bone; they are recognized by fluctuation, want of pulsation, compressibility, and swelling on forced expiration. The tumor must be destroyed by (1) excision, when the growth is large, the line of incision being quite external to the capsule; (2) injection of persulphate of iron, in small quantities, when the tumor is small, and not amenable to other remedies, as on the face, great care being taken to compress the vessels around the tumor to prevent the escape of the fluid into the general circulation.

III. THE CAPILLARIES.

The capillaries may form vascular or erectile tumors, consisting almost exclusively of vessels held together by connective tissues.

The plexiform angioma, telangiectasis, cutaneous nævus, is composed entirely of dilated and tortuous capillaries and anastomosing vessels, and occurs almost exclusively in the cutis; they may be of a dark cherry, or a steel-blue color, according as the superficial or deep-seated vessels of the cutis are involved; they are sometimes as large as a pin's-head, and again as a hempseed; some are moderately thick, others scarcely rise above the level of the skin; as a rule, this proliferation of vessels does not extend beyond the subcutaneous cellular tissue, their growth is always slow and painless;[1] they frequently not only cease to enlarge, but undergo a gradual contraction and obliteration; hence the propriety of treating them at first with mild remedies, as pressure, applications of collodion, vaccination. If more radical measures become necessary, inject persulphate of iron, using precautions by pressure around the growth to prevent the entrance of coagula into the circulation; or pass red-hot needles under it at several points and secure a slough. Strangulation of the mass by subcutaneous ligature, when the growth is accessible, is adapted to the larger nævi, and may be applied in many ways, as follows: (1) The single ligature; strong whip cord (Fig. 175), is carried around the tumor by entering it at one point and carrying it as far as possible round the base, then emerging

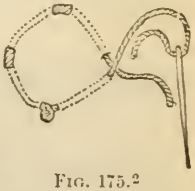


Fig. 175.[2]

[1] T. Billroth.

[2] T. Holmes.

and reëntering at the same puncture and carried around another portion, until it reaches the point of first entrance, where the two ends are firmly tied; (2) or, if the growth is too large, the ligature may be carried, double, under the tumor, and then each section may be carried round the half as before, and tied (Fig 176).

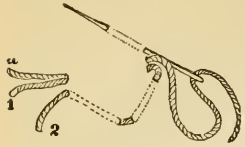


Fig. 176.

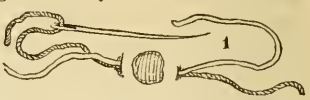


Fig. 177.

For a large nævus the following knot may be made :[1] Pass the needle under the centre of the tumor (Fig. 177), divide one thread near the needle; pass the other end of the ligature into the needle's eye; now enter the needle at a quarter of the circumference and pass it under the base at right angles to its former direction (Fig. 177;) before tying the ends make a lunated incision between each puncture into which the ligature sinks; finally, tie the opposed ends (Fig. 179).

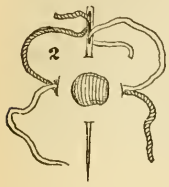


Fig. 178.

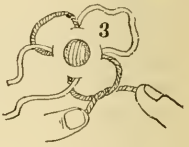


Fig. 179.

If the tumor is elongated in form the ligature may be applied as follows (Fig. 180): Pass a double ligature under its base from side to side; color the end of one ligature white and the other black; leave each loop long, the whole ligature being of great length; divide the white loops on one side and the black on the other, and tie the pairs of white and black strings tightly; the skin is destroyed by this method.[2]

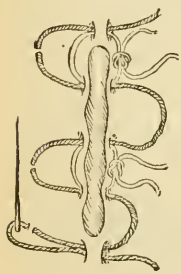


Fig. 180.

CHAPTER XXIII.

GENERAL OPERATIONS ON THE CIRCULATORY SYSTEM.

I. THE HEART.

The only general operation on the heart and pericardium is undertaken for the relief of dropsy. In order to perform any operation upon this organ it is important to be able to define its normal position.

[1] Sir W. Fergusson. [2] T. Holmes.

That part of the heart which lies immediately behind the wall of the chest, and is not covered by lung, is sufficiently defined for all practical purposes by a circle two inches in diameter round a point midway between the nipple and the end of sternum; the apex pulsates between the fifth and sixth ribs, two inches below the nipple, and one inch to its sternal side, this point varying slightly with the position of the body, and with inspiration and expiration.[1]

Paracentesis of the pericardium is practiced as follows: The most prominent point being carefully determined, select the left fifth intercostal space, from two fifths of an inch to two inches from the sternum, according to the prominence of the sac;[2] make an incision a little more than an inch long parallel to the ribs in the centre of the space commencing about two fifths of an inch to the left of the sternum; carefully divide the layers of muscle until an elastic dilatation is felt which resists under pressure with an indistinct impulse of the apex of the heart; make a slight puncture and introduce a small trocar[3] or the aspirating needle.

II. THE ARTERIES.

The general operations upon the arteries are arteriotomy and ligation.

The arteries possess considerable strength and a high degree of elasticity, being both extensible and retractile in width and length; they are inclosed in a sheath of connective tissue and have three independent coats, namely, internal, middle, and external; the internal coat consists of epithelium and elastic tissue; the middle of muscular fibres disposed circularly round the vessel, and the external of elastic and connective tissue; arteries are accompanied by one or more veins, and nerves.[4]

Arteriotomy, very rarely practiced, is performed to secure sudden loss of blood and thus make a profound impression on the system or relieve sudden congestion. The temporal artery is preferred, and the anterior branch selected. Incise its coats obliquely with a sharp-pointed lancet or bistoury, and when sufficient blood has flowed, divide it completely, and apply a compress and bandage.

The ligation of an artery is still the more common method of radically treating aneurisms. Before the operation the following facts should receive due consideration: —

1. The instruments required are a scalpel, forceps, aneurismal needle, ligature, director, and spatulas. The common scalpel is best adapted to the dissection, and the broad extremity of the handle can be used to advantage in separating layers of fascia, and parts where the cutting edge is not desirable; the dissecting forceps should have accurately fitting teeth, and not be liable to open at the extremity when firmly closed; a pair of small forceps may also be required. The aneurism needle is a curved blunt instrument, with

[1] L. Holden. [2] Rogèr; Dieulafoy. [3] T. C. Albutt. [4] Quain's Anatomy.

an eye near the extremity, and firmly fixed in a handle (Fig. 182). When used, the extremity is gently insinuated under the vessel, and as it appears upon the opposite side, the loop of the ligature is seized with the forceps, or a hook, and one end being drawn through, it is held as the instrument is withdrawn carrying the other end, and thus leaving the ligature under the vessel. A needle well adapted to those cases where the artery lies deeply consists of the handle and hook (Fig. 184), and the blunt needle with two eyes (Fig. 183); the needle is fitted to the shaft (Fig. 184) by a screw; when used, the ligature is inserted into the second eye; the needle is then passed under the artery, and as the extremity emerges upon the opposite side, the blunt hook is inserted into the eye, and the needle is thus held until the handle is unscrewed, when it is drawn through with the ligature. It is sometimes necessary to include other tissues with the artery, when the sharp pointed needle (Fig. 183) should be used. The director is used in the dissection to raise the fascia before its division; it is sometimes passed under the artery as a guide to the needle. Two spatulas are often required, with which assistants separate the sides of the wound, and expose the deep-seated parts; pieces of flexible metal or wood may be used; the ligature is generally of the strongest dentists' silk, or of silver wire, its size proportionate to the size of the vessel; in general a large ligature irritates more than a small one, and is longer in separating. If carbolized catgut is used it must not be too hard, or it will be too stiff for tying, and will even act as a foreign body as much as silk does, and yet it must be so hard that after soaking in serum for weeks, it will still hold firmly; old ligature is far preferable to new [1]

Fig. 182.

Fig. 183.

2. The patient must be placed upon a firm bed, or on a table, and the assistant administers the anæsthetic; the surgeon takes his position generally on the outside of the limb which is the seat of the operation; a second assistant takes a position where he can command the artery above if by any accident it is wounded, or if the artery yields under the tightened ligature; a third uses the sponges; and a fourth separates the wound with the spatulas. The steam or hand

[1] J. Lister.

spray apparatus should be used during the operation, or a carbolic solution should be thoroughly applied to the wound after the ligature is applied.

3. The precise location of the artery is determined, (1) By its pulsations; (2) by given anatomical points in the vicinity. To ren-

Fig. 184.

der the former distinct, the limb should be placed in a position favorable to arterial circulation; to render muscles and tendons most distinct the limb should be forcibly extended at the commencement of the operation. When the dissection has proceeded so far as to reach the vicinity of the artery, the operator is aided in detecting its position by flexing the limb so as to relax the muscles and tissues. The point of application of the ligature, when it is applied for aneurism, will depend upon the situation and condition of the aneurism. It should be applied (1) on the cardiac side at a distance from the tumor, 2 (Fig. 185),[1] when the artery can be tied with comparative ease and safety, as the femoral for popliteal aneurism; (2) on the cardiac side, near the tumor, 1 (Fig. 185),[2] when the space between the tumor and important parts on the proximal side is slight, and the artery in this space is sound, as the external iliac for aneurism of the femoral near Poupart's ligament; (3) on the distal side, 3 (Fig. 185),[3] when the proximal ligature is impossible, as the axillary for subclavian aneurism; (4) on a distal branch, 4 (Fig. 185),[4] when the cardiac and distal ligature of the main trunk is impracticable, as in the subclavian for innominate aneurism; (5) at the aneurism, the old operation, when the tumor is so situated that it is inadmissible or impracticable to ligate the trunk on the cardiac or distal side.

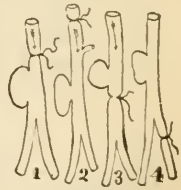


Fig. 185.

4. It is important, before the first incision is made, to guard against wounding superficial veins. Their position is readily defined by compressing the parts above the point of the proposed operation.

5. The operation involves several consecutive steps: When the first incision is about to be made, the skin should be rendered tense by the thumb and fingers of the left hand applied on either side of the vessel, or the fingers applied at the extremity of the proposed incision, parallel to its course; if the first method is chosen, care

[1] J. Hunter. [2] Anel. [3] Brasdor. [4] Wardrop.

must be taken not to make more traction on one side than on the other. The second method answers where the skin is naturally tense and but slight traction is necessary. Hold the scalpel in the second or third position (Figs. 27, 28); make the incision directly over and parallel to the artery, through the skin only if the artery is superficial, but also through the cellular tissues if it is deep, its length varying with the depth of the vessel and the adipose tissue. The incision is sometimes made in the direction of the fibres of the muscle covering the artery, as where the great pectoral overlies the axillary; at other times it should be curved, so as to raise a flap. The length of the incision cannot be prescribed, but it should always be ample. Pinch up the fascia carefully with the forceps (Fig. 186), nick it with the scalpel applied horizontally; incise freely on a director introduced beneath. In dissecting among muscular structures enter the muscular interstices, and not wound the substance. These inter-muscular spaces are marked by deposits of fat, especially towards the terminal extremity of the muscles, and hence we should commence the separation of muscles as nearly as possible at their terminal extremity. If there is doubt as to the line of separation, a puncture will disclose adipose or muscular tissue, according to the nature of the underlying structure. If the dissection is made through the body of the muscle, the fibres separate more readily in an inverse direction, namely, from their origin to their attachments. The muscles may be separated with the handle of the scalpel or the finger nail. The larger arteries have firm sheaths, which require to be opened by dissection; the smaller vessels have but slight fibrous investments, and are readily exposed with the point of a director, or the aneurism needle. The sheath opens by pinching up a small portion with the forceps, and nicking it slightly with the scalpel; into the opening thus made, introduce the director or the needle, and by slight movements of its point, first upon one side and then upon the other, separate the sheath completely around the vessel, to an extent sufficient to allow simply the passage of the lig-

Fig. 186.

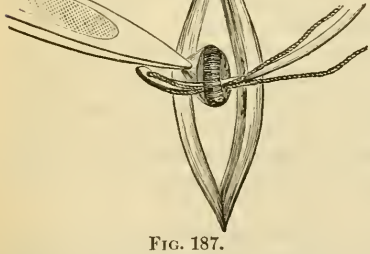


Fig. 187.

ature; as the extremity of the instrument emerges on the opposite side, with the finger of the left hand, or the thumb and forefinger pressed together, steady its point as it penetrates the last portion of the sheath. If the artery is small and very superficial, a director may be passed under, and along its groove, a blunt needle carrying the ligature. If more deeply situated, the common aneurism needle (Fig. 182), or the double-eye needle (Fig. 183), should be used. The point of the needle gently moved laterally, aids materially in separating the artery from the sheath. The needle should be passed from the veins; no force should be used, lest the instrument penetrate the coats of the artery.

The ligature should be placed at right angles with the long axis of a vessel, and the reef-knot (Fig. 12) tied, unless there are special reasons for adopting the surgeon's knot (Fig. 11). The first knot is tightened around the vessels firmly, on either side of the ligature, near the artery, with the index fingers carried to the bottom of the wound (Fig. 188). The degree of constriction varies with the size of the arteries, but it should always be sufficient to rupture the internal coats when silk is used, the sensation of which is communicated to the fingers. In tying the second knot care must be taken not to tighten the thread firmly until traction is made on a plane with the first knot, with the fingers again carried down to the vessel. The two ends of the ligature are tied together, and being brought out of the wound at its most dependent part, are fastened to the external parts by an adhesive strap; the edges of the wound are brought together by adhesive straps, or if the wound is deep and gaping, sutures are used.

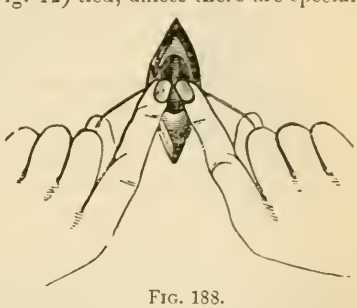


Fig. 188.

ARTERIES OF THE THORAX, NECK, AND HEAD.

The general rules concerning the management of aneurisms and the ligation of arteries, for their cure, in this region, are as follows:[1]—

Aneurism of the arch of the aorta is best treated by rest, unstimulating diet, sedatives, and iodide of potassium; the ligature is justifiable only when the aneurism is believed to implicate the transverse portion of the arch and be extending along the course of the carotid into the neck, in which case the corresponding artery, generally the left, may be tied. In innominate aneurism, when medical treatment has failed, the tumor extends, especially along the trachea,

[1] T. Holmes.

as will be proved by its growth and the increasing dyspnœa; it is justifiable to tie the right carotid, and perhaps also the subclavian artery. Aneurism of the common carotid low down in the neck may be treated with good prospect of success by the distal ligature.[1] Aneurism near the bifurcation, or in one of the secondary carotids, or their branches, may be treated by compression of the common carotid at the anterior tubercle of the fifth cervical vertebræ; if this fail or is impracticable, and the artery is easily accessible, apply a ligature to the trunk. In extreme cases an aneurism may form in the carotid which, from its position and extent, does not admit of the proximal ligature, and from its condition does not warrant the distal ligature; in such a case the operation of laying open the sac and tying the artery at its entrance to the tumor has been recommended[2] as follows: The patient being under an anæsthetic, with shoulders slightly elevated, pass the knife into the most prominent part of the tumor, and follow the blade with the forefinger of the left hand so closely as to prevent the effusion of blood; search with the end of this finger for the opening in the artery, and when found, which may be known by a cessation of pulsation, press firmly; now lay the cavity freely open, turn out the clots, sponge away the blood, and expose and ligate the artery first on the cardiac, and then on the distal side.

1. **The innominate** arises from the right superior portion of the arch of the aorta, in front of the left carotid, and passes in an oblique direction, upwards, outwards, and backwards, to the superior margin of the sternal articulation of the clavicle, where it divides into the right subclavian and right common carotid, being from one and a half to two inches in length.

It is in relation on the right with the pleura, right vena innominata, and right pneumogastric nerve; behind, with the trachea; on the left, with the left carotid; in front, above, with the sternum, and the origin of the sterno-hyoid, and thyroid; below, with the inferior thyroid vein and left vena innominata.

Place the patient on the back, with the shoulders slightly raised, and face turned to the opposite side; make an incision three inches in length, just above the clavicle, terminating over the trachea, and, if required, a second of the same length, from this point along the inner border of the sterno-mastoid; divide the sternal and part of the clavicular portion of the sterno-mastoid and turn outwards; divide the sterno-hyoid and thyroid, draw them inwards, exposing the sheath of the carotid, par vagum, and internal jugular vein; now separate the par vagum from the carotid; draw the vein to the outside, and the artery towards the trachea, and expose the subclavian; pass the needle from below up-

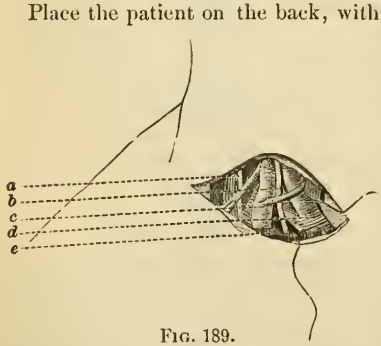


FIG. 189.

[1] Brasdor. [2] J. Syme.

wards and inwards; care is necessary to avoid wounding the pleura behind.

Make an incision three inches in length, extending from a point midway between the two sterno-mastoid muscles, towards the right shoulder, half an inch above the clavicle (Fig. 189); incise the skin and platysma; then, on a director, divide the sterno-mastoid, *c*, and sterno-hyoid and thyroid successively; with the handle of the knife the artery, *d*, is isolated, care being taken to avoid the pneumogastric nerve, *b*, the internal jugular vein, *c*, and the phrenic nerve, *a*.

2. **The subclavian and common carotid arteries** (Fig. 190) may be ligated by the following operation: Place the patient in the position for ligature of the innominate; make an incision three inches in length through the integuments, along the space separating the clavicular and sternal attachments of the sterno-cleido-mastoid muscle; this interval is marked by a depression above the clavicle, at the articulation of the clavicle and sternum; flex the head; slightly separate the internal portion of the muscle, *a*, from the external, *b*; divide the sterno-hyoid and thyroid on the director; the innominate, *h*; the common carotid, *e*; the pneumogastric, *d*, and its branch, the recurrent laryngeal; the origin of the subclavian, *g*, and its branches, the vertebral, *c*, and inferior thyroid, are now readily seen.

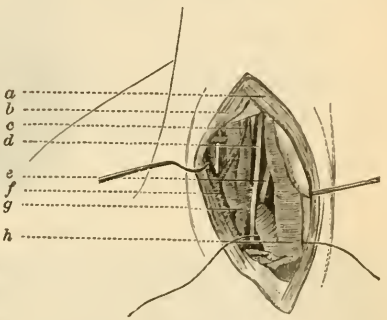


Fig. 190.

3. **The common carotid arteries** extend on the right side from the innominate, and on the left from the highest point of the arch of the aorta, to the upper border of the thyroid cartilage; the direction is obliquely from before backwards, and from within outwards, along the external side of the trachea and larynx, in a line drawn from the sternal end of the clavicle, below, to a point midway between the mastoid process and angle of the jaw above. Its sheath is derived from the deep fascia, and contains the internal jugular vein and the pneumogastric nerve, the vein being external, and the nerve between.

(*a*.) At the base of the neck the artery is deeply seated, and a ligature should be applied at this point only from necessity.

In front is the platysma, superficial and deep fasciæ, the sterno-mastoid, sterno-hyoid, and sterno thyroid muscles; externally it is in relation with the pneumogastric nerve and internal jugular vein; internally with the trachea; posteriorly with the longus colli and rectus anticus major muscle; the internal

jugular of the right side recedes from the artery, but on the left approaches and often overlaps it. The carotid tubercle is a guide to the position of the artery;[1] this tubercle is the anterior projection of the transverse process of the sixth cervical vertebra, which is two inches above the clavicle, and is a precise guide to the artery when the neck is straight; it corresponds in front and a little inside to the artery.

Operate as follows (Fig. 191):[2] Place the patient on the back, the

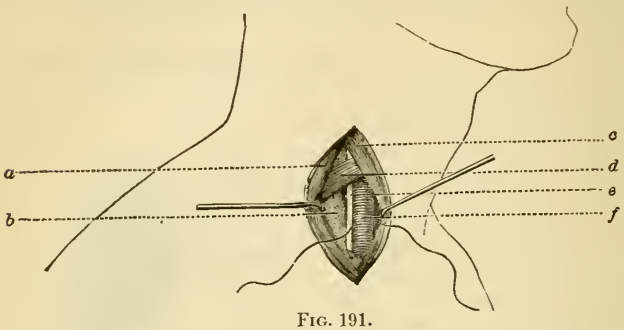


FIG. 191.

head extended and inclined to the opposite side; recognize the interval between the two attachments of the sterno-mastoid muscle, and make an incision from the clavicle, two and a half inches, obliquely, along this interspace; divide the skin, platysma, and deep fascia; draw the internal portion of the muscle, *c*, inwards, and the external, *a*, outwards, by means of spatulas; this exposes the internal jugular vein, *b*, and the pneumogastric nerve, *e*, lying between the vein, *b*, and the artery, *f*, and the omo-hyoid muscle, *d*, crossing the upper part of the wound; open the sheath and pass the needle from without inwards, carefully avoiding the internal jugular vein and par vagum; a finger pressed upon the vein at the upper part of the wound will cause it to collapse.

(*b.*) Below the omo-hyoid the artery is much more accessible.

It is covered by the integument, the platysma, the superficial and deep fasciæ, the sternal part of the sterno-mastoid, the sterno-hyoid and thyroid muscles; it is crossed obliquely, from within outwards, by the sterno-mastoid artery, also by the superior and middle thyroid veins, and lower down by the anterior jugular; on the outer side are the pneumogastric nerve and internal jugular vein, and on the inside are the inferior thyroid artery and recurrent laryngeal nerve, which separates it from the trachea and thyroid gland; the descendens noni nerve lies on the sheath of the artery.

Operate thus (Fig. 192): Place the patient on the back, with the head thrown back; make an incision three inches in length along the inner border of the sterno-mastoid muscle, in the line above given;

[1] Chassaignac. [2] Sédillot.

commencing on a level with the cricoid cartilage, successively divide the skin, superficial fascia, platysma, and deep fascia, and expose the inner border of the sterno-mastoid, *e*; carefully avoid the sterno-mastoid artery and middle thyroid vein; throw the head forward and draw the sterno-mastoid muscle outward, and the sterno-hyoid and thyroid muscles inwards; expose the anterior belly of the omo-hyoid muscle, *a*, which should be drawn upwards; divide the deep fascia;

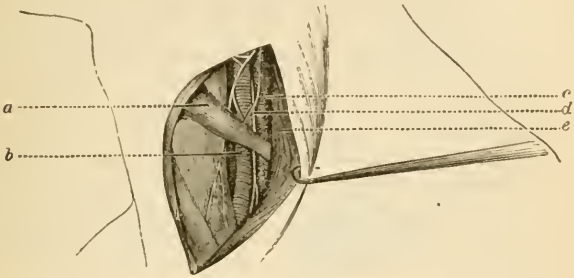


FIG. 192.

expose the sheath of the vessel; open it directly over the artery, avoiding carefully the descendens noni, which runs along the tracheal side; press the pneumogastric nerve, *d*, and internal jugular vein, *c*, outward, and pass the needle from without inwards, carefully isolating the vessel from the inferior thyroid artery, and recurrent laryngeal nerve which lies behind it.

The thyroid body may be so large as to mislead as to the margin of the muscle, and then requires careful dissection; if the omo-hyoid muscle interferes with the operation it may be turned aside, or even divided by dissection.

(*c.*) Above the omo-hyoid the artery is still more superficial, being covered only by the skin, the two fasciæ, platysma, and the border of the sterno-mastoid; it is in relation internally with the larynx and pharynx, and externally with the pneumogastric nerve and internal jugular vein. Operate as follows: Place the patient on the back, the shoulders raised, and the head turned to the opposite side; make an incision from a little below the angle of the jaw, in the line given, along the internal border of the sterno-mastoid, three inches in length: divide the integuments, superficial fascia, and platysma; raise the deep fascia carefully on a director; avoid the small underlying veins; flex the head to relax the muscles, and draw the wound apart by spatulæ; avoid the descendens noni nerve and superior thyroid arteries, and open the sheath over the artery; if the internal jugular vein swell up into the wound, compress it in the upper and lower part of the wound, and draw it outwards; pass

the ligature from without inwards, the point of the needle being kept close upon the artery, to avoid wounding the vein or including the pneumogastric nerve.

3. **The external and internal carotids** arise from the common trunk at the upper border of the thyroid cartilage, the external being more superficial and internal at their origins.

They occupy the triangle formed by the sterno-mastoid behind, the omo-hyoid below, and the posterior belly of the digastric and stylo-hyoid above; and are crossed by the hypo-glossal nerve, and the lingual and facial veins.

Operate as follows: Make an incision along the inner margin of the sterno-mastoid, three inches in length, from the angle of the jaw to the cricoid cartilage, through the skin, platysma, superficial and deep fascia; the internal margin of the sterno-mastoid now appears; cautiously separate the cellular tissue, and the wound being drawn apart, the artery is exposed; draw the digastric muscle and hypo-glossal nerve upwards, and the internal jugular outwards; both arteries may now be ligated or either artery separately. The carbolized catgut ligature should be used and the wound closed to avoid all suppuration.

4. **The external carotid artery** ascends from its origin at first, slightly forwards, then backwards, to the space between the condyle of the lower jaw and the meatus auditorius; above the digastric the artery lies more deeply and is crossed by the stylo-hyoid muscle. Operate thus: Make an incision from the lobe of the ear to the great cornu of the hyoid bone, along the inner margin of the sterno-mastoid; divide the skin, platysma, and fascia; separate the posterior belly of the digastric and stylo-hyoid from the parotid gland, by depressing the muscles, and the artery will be exposed.

5. **The superior thyroid artery** arises from the external carotid, just below the greater cornu of the hyoid bone, and passes inwards to the thyroid gland in a tortuous course; it is at first superficial, lying in the triangle formed by the sterno-mastoid, digastric, and omo-hyoid muscles. It is ligated thus: Place the head in an extended position; make an incision an inch and a half along the internal border of the sterno-mastoid, the centre of which corresponds to the great cornu of the thyroid cartilage; incise the skin and platysma; draw the sterno-mastoid outwards and expose the omo-hyoid muscle, internal jugular vein, and primitive carotid artery; the artery lies between these vessels and the lobe of the thyroid body, and is readily ligated.

6. **The lingual artery** is the second branch of the external carotid; it arises just above the superior thyroid, ascends to the great cornu of the hyoid bone, runs parallel with it and passes directly to the base of the tongue (Fig. 193). Turn the head to the opposite

side; make an oblique incision an inch and a half in length, a little above the body of the hyoid bone, and parallel with it, near the median line, and curved backwards, outwards, and downwards, parallel with the superior border of the great cornu of the thyroid cartilage; divide the superficial parts and with the finger recognize the direction of the great cornu: divide upon it the aponeurosis which covers the deep parts; this exposes the digastric muscle, the submaxillary gland, hypoglossal nerve, and stylo hyoid muscle, *a;* now isolate the great cornu of the hyoid bone, and the fibres of the hyoglossus muscle, which are attached at this point, come into view;

FIG. 193.

divide this muscle at the superior border of the great cornu; draw it upwards and backwards, and the artery is found behind it; the needle should pass from below upwards.

Or, having recognized the position of one of the greater cornua of the hyoid bone, make an incision about an inch in length, parallel with, and about two lines above it, through the skin, cellular tissue, and platysma; this incision will expose the lower border of the submaxillary gland, on lifting which slightly, the shining tendon of the digastric will be recognized; less than a line below this lies the hypoglossal nerve, and at the distance of a line below the nerve, a transverse incision through the fibres of the genio-hyo-glossus muscle will certainly expose the artery, which, in this situation, is accompanied by neither vein nor nerves.[1]

7. **The facial artery** (Fig. 194) passes over the lower jaw, at the anterior border of the masseter muscle, *a;* it lies on the periosteum, and in a groove which is recognized at the junction of the posterior third with the anterior two thirds of the body of the bone; the facial vein lies on the outer side. The pulsation of the artery being recognized, make an incision an inch in length, along the course of the vessel, as already given, through the skin, fascia, and platysma; the wound being separated, and the fibrous tissue divided, the artery, *c,*

[1] J. F. Malgaigne.

is exposed, and the vein, *b*, and masseter muscle, *a*, are drawn outwards, and the needle passed.

8. **The temporal artery** (Fig. 194) runs upwards towards the temporal region from its origin at the condyle of the jaw, in front of the concha; two inches above the zygoma it divides into the anterior and posterior branches. Recognizing the position of the artery by its pulsation, at a point above the zygomatic arch, and in front of

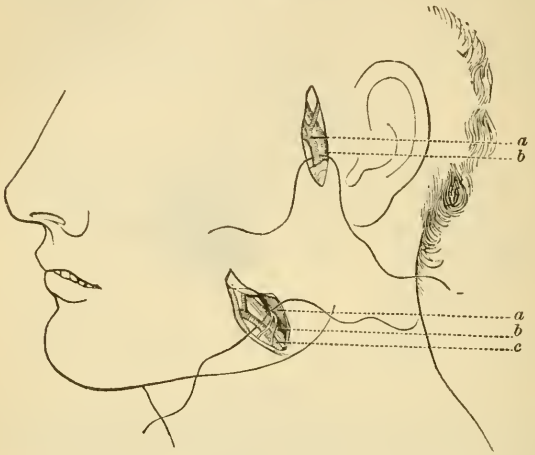


FIG. 194.

the ear, make an incision through the skin, an inch in length; divide the dense cellular tissue on a director, and the artery, *a*, will be exposed; pass the needle from behind forwards to avoid the temporal vein, *b*, and the auriculo-temporal nerve.

9. **The occipital artery** arises from the external carotid, opposite the facial, ascends to the space between the transverse process of the atlas and the mastoid process, and passes up upon the occiput.

(*a*.) At its origin the artery is covered by the stylo-hyoid and digastric muscles, and the hypoglossal nerve winds around it from behind forwards. Make an incision along the inner border of the sterno-mastoid muscle, two inches in length, at the angle formed by this muscle and the digastric; the deep fascia being carefully divided, expose and isolate the artery, the nerve being carefully protected.

(*b*.) Behind the mastoid process (Fig. 195) the artery passes upwards, in a tortuous direction, and divides into branches, upon the occiput; it is covered by the sterno-mastoid and splenius muscles. Make an incision one inch long, half an inch behind and a little beneath the mastoid process, obliquely upwards and backwards; di-

vide the skin and aponeurosis of the sterno-mastoid muscle, *c*, as also the splenius muscle, through the whole length of the wound; the pulsations of the artery, *a*, are recognized by the finger a little above the oblique muscle, *b*, and it is isolated from its veins.

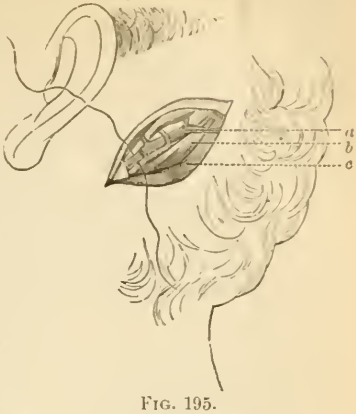


Fig. 195.

10. **The internal mammary artery** arises from the subclavian, and descends behind the clavicle on the inner surface of the costal cartilages near the sternum.

The internal jugular and subclavian veins and the phrenic nerve cross the upper part; in the chest it at first lies on the costal cartilages and intercostal muscles, covered by the pleura behind; but lower it is covered also by the triangularis sterni muscle; it may be tied in the second, third, or fourth intercostal spaces.

Make an incision along the upper edge of the rib, commencing at the sternum, in either space, slightly upwards, and outwards, an inch and a half in length: divide the skin, cellular tissue, pectoralis major muscle, fascia, and intercostal muscle successively; a thin layer of cellular tissue is exposed, which conceals the artery; pass the needle cautiously from within outwards.

11. **The vertebral artery** arises from the subclavian artery in the first part of its course, and passes directly along the spinal column, to the foramen in the transverse process of the sixth cervical vertebra, and along the canal to the brain.

(*a.*) Before entering the vertebral canal the artery passes behind the internal jugular vein and inferior thyroid artery, to the spine, where it lies between the scalenus anticus and the longus colli, and in a line drawn from the posterior part of the mastoid process to the junction of the internal fourth with the external three fourths of the clavicle. Place the patient on the back, the shoulder depressed, and the head turned to the opposite side; make an incision three inches in length along the inner border of the sterno-mastoid muscle, between it and the sterno-hyoid, terminating at the middle of the upper extremity of the sternum; divide the skin, cellular tissue, and the aponeurosis uniting the sterno-mastoid muscle and sterno-hyoid; bring into view the common sheath of the carotid, the internal jugular, and the pneumogastric nerve; separate with the finger the cellular connection of the sheath with the sterno-thyroid muscle, and finally with the longus colli; the head is now raised, though still

turned to the opposite side, and the sides of the wound forcibly separated; divide the cellular tissue at the bottom, and expose an aponeurosis which passes from the scalenus anticus to the longus colli, and the anterior part of the transverse process of the sixth cervical vertebra, the carotid tubercle; then open the aponeurosis an inch below this point, at the external border of the longus colli muscle; the artery is exposed very deeply.

(*b.*) Between the atlas and axis the artery lies in a triangular space formed by the rectus posticus minor and superior and inferior oblique muscles, and is covered by the rectus posticus major and complexus. Turn the head to the opposite side, and incline it forwards; make an incision two inches long on the posterior edge of the sterno-mastoid, commencing half an inch above the mastoid process; make a second incision, an inch in length, from the upper fourth of the first incision backwards and obliquely downwards; divide the skin and cellular tissue; then the splenius muscle with its fibrous expansion; a fibrous layer now appears, which must be cautiously divided to arrive at the small arteries which lie beneath it; the edges of the wound being separated, a layer of fat appears, which is cautiously opened with the finger or handle of the scalpel, and the artery is found within; the two branches of the occipital artery are to be drawn aside, as also branches of the second cervical nerve; the artery is isolated, and the needle passed from without inwards to avoid the internal carotid artery.

(*c.*) Between the atlas and occiput the anatomical relations are as given above. The incisions are the same as in the last operation, except that the first commences one fourth of an inch above the mastoid process; divide the skin, fascia, and splenius muscle; the occipital artery appears at the upper angle of the first wound, and is held aside; divide the underlying aponeurosis, with the cellular tissue; separate the edges of the wound, and in a triangle formed by the muscles of the part, the cellular tissue, loaded with fat, covers the artery; divide this and the artery is exposed; pass the needle from behind forwards.

12. **The inferior thyroid artery** is a branch of the thyroid axis; it ascends the neck obliquely, passing behind the internal jugular, the pneumogastric nerve, the carotid artery, and omo-hyoid muscle, to the thyroid body. It may be ligated through the same incision as is made for the ligature of the common carotid (Fig. 190).

ARTERIES OF THE UPPER LIMB.

The following general rules should guide in the ligation of arteries of the upper extremity for aneurism: —

Aneurism of the subclavian is usually fatal if left to itself,[1] and surgical treat-

[1] T. Holmes.

ment generally only hastens death; if it occurs in the first or second part of the artery the ligature can only be applied to the innominate, if in the third part of the right, it must be applied to the first part of the same vessel, but both operations have proved so uniformly fatal that they do not warrant the trial. The carbolized catgut ligature, used with all necessary antiseptic precautions, may prove entirely successful, as it does not involve the dangers of the division of the coats of the artery, nor of suppuration in the wound.[1] Axillary aneurism should first be treated by compression of the subclavian in its third part with the fingers or an instrument; if this fail, ligature of the subclavian in its third part may be resorted to. Or, especially in traumatic aneurism, the sac may be laid open, and the vessel found and tied,[2] pressure being made upon the subclavian over the first rib, an incision being made if necessary to reach the artery; the relation of the artery to the sac and the nerves is very variable.[3] Aneurisms of the vessels of the arm and forearm, if spontaneous, are commonly associated with disease of the heart or general arterial degeneration, and ought not to be actively treated;[3] if traumatic, they should be laid open and the vessel tied at the point where it is torn.

1. **The subclavian artery** arises from the innominate on the right side, and from the arch of the aorta on the left; it extends in a curved direction from its origin to the lower border of the first rib.

(*a.*) Within the scaleni, on the right side, the artery passes upwards and outwards from its origin from the innominate across the neck to the internal border of the scalenus anticus muscle.

It is very deeply situated, and lies upon the pleura; its anatomical relations are, in front, the skin, fasciæ, platysma, origin of sterno-mastoid, sterno-hyoid, and thyroid muscles; it is also crossed by the pneumogastric, cardiac, and phrenic nerves, and by the internal jugular and vertebral veins; behind, it is in relation with the recurrent laryngeal and sympathetic nerves. On the left side the artery extends from the left portion of the arch of the aorta to the scalenus anticus, situated very deeply, and passing upwards, almost vertically; in addition to the anatomical relations of the right, the left has in front the pleura, the lung, and the carotid, and internally the œsophagus, trachea, and thoracic duct.

(*b.*) The right subclavian is ligated thus: Place the patient on his back, the shoulders raised, and the head turned to the opposite side; make two incisions, one parallel with the inner part of the clavicle, and the other along the inner border of the sterno-mastoid; pass a director behind the sternal attachment of the sterno-mastoid, and divide the cellular tissue; avoid small arteries and veins in this part, and especially the anterior jugular; divide the sterno-hyoid and thyroid muscles on a director; open the deep fascia with the finger-nail, or end of the director, and expose the internal jugular, which being pressed aside, pass the needle around the artery from below upwards to avoid the pleura. The left subclavian is ligated thus: Place the patient in the position above described; make an incision three and a half inches long on the inner edge of the sterno-mastoid, ter-

[1] J. Lister. [2] J. Syme. [3] T. Holmes.

minating at the sternum, through the skin and platysma; this is met by another incision along the sternal extremity of the clavicle, two and a half inches; dissect the flap and divide the sternal and half the clavicular origin of the sterno-mastoid on a director, and raise the flap; divide the deep fascia with the handle of the scalpel and the fingers; continue the dissection along the outer side of the deep jugular vein to the inner edge of the scalenus anticus muscle, half an inch above the rib, to avoid the thoracic duct; the phrenic nerve is detected and avoided, and the fingers pressed to the bottom of the wound discover the rib, and then the artery; pass the needle from below upwards.[1]

(*c.*) Between the scaleni the artery is very short; it is covered by the integuments, platysma, sterno-mastoid, and the scalenus anticus, upon which lies the phrenic nerve; below is the pleura and above the brachial plexus. The ligature has seldom been applied at this point. Make a deep incision; the tubercle of the rib being recognized, and the insertion of the muscle into it, pass the director behind it and between the muscle and the artery, and with a bistoury, divide the muscle; its retraction exposes the artery, which is readily ligated; pass the needle from without inwards. Or, divide the muscle from without inwards, commencing some distance from the rib. The phrenic nerve is liable to be divided, unless this proceeding is adopted; the internal mammary artery may be wounded if the incision is too near the rib.

(*d.*) Outside of the scaleni muscles (Fig. 196) the artery, *b*, passes downwards and outwards, lying in a groove on the first rib.

It first passes through the supra-clavicular triangle, and is then covered only by the deep fascia, the platysma, and skin; lower in its course it is covered by the clavicle and subclavian muscle; the subclavian vein, *h*, lies lower and in front of the artery, separated from it by the insertion of the scalenus anticus muscle, *c;* the external jugular vein crosses in front of the artery; the brachial plexus of nerves lies above and behind the artery. The depth of the artery may vary from one to three inches, according to the depth of fat.

Search for the artery (Fig. 196) in the supra-clavicular triangle, which is bounded externally by the omo-hyoid muscle, internally by the scalenus anticus, and below by the first rib; place the patient on his back, the shoulders depressed, and the head turned to the opposite side; the skin over the parts being drawn down upon the clavicle, make an incision along the bone, from the anterior border of the trapezius to the posterior border of the sterno-mastoid, *e:* divide the platysma and superficial fascia, care being taken to draw the external jugular outward, or, if cut, to tie the ends; with the director and finger separate the cellular and fatty tissue, and draw the omo-hyoid

[1] J. K. Rodgers.

muscle aside; divide the deep fascia and the border of the scalenus, *d*, being defined, pass the finger along its margin down to the first rib, recognize the tubercle for the attachment of that muscle, just external to which the artery, *b*, will be felt pulsating; separate the attachments of the artery with the finger nail, and gently insinuate the aneurism needle beneath it, from before backwards and slightly

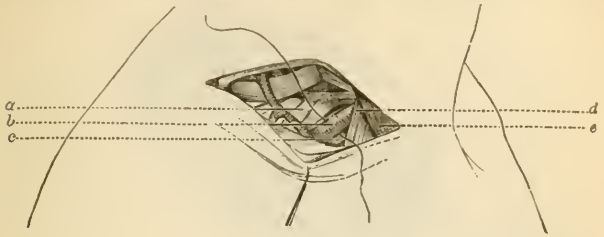


FIG. 196.

from within outwards, avoiding the vein, *c;* guide the point of the needle by the end of the finger, and prevent it, when it emerges upon the opposite side, from engaging a branch of the brachial plexus, *a*.

It must be remembered that the sterno-mastoid may have an unusually extended insertion upon the clavicle, as also the trapezius, in which case the incision must involve the clavicular attachments of the former; the external jugular may run so near to the sterno-mastoid as to be involved in the incision, unless it is carefully isolated and drawn to the outer or inner side; the transverse cervical and supra-scapular arteries may be met with in this dissection, and if wounded should be immediately ligated; the tubercle of the rib is sometimes not well defined, in which case the attachment of the scalenus to the rib is the guide to the artery, which is found just posterior to its insertion.

2. **The axillary artery** extends from the lower border of the first rib to the lower margin of the tendon of the latissimus dorsi, or the inferior boundary of the axilla, in a line dividing the anterior and middle third of the axilla. It may be ligated in two places.

(*a*.) Below the clavicle (Fig. 197) in its upper part, the axillary artery is covered successively by the insertion of the pectoralis minor, *j;* higher up by the pectoralis major muscle, *i*, from which it is separated by a layer of adipose tissue, containing numerous small veins and arteries; and finally by the fasciæ and the skin.

The suprascapular artery, *a*, crosses the base of the neck just above the clavicle; the axillary vein, *h*, in front and to the inner side of the artery, is not in immediate contact with it; the cephalic vein passes upwards in the interspace between the deltoid and pectoralis major muscles, crosses the axillary artery above the pectoralis minor, and empties into the axillary vein; the nerves, *b*, of the brachial plexus, *c*, lie behind and above; a thoracic branch often crosses the artery, sometimes in front, and sometimes behind it.

Place the patient on his back, with his shoulders slightly raised, the elbow a little separated from the body, and the head inclined to the opposite side; make an incision three inches in length, three quarters of an inch below the clavicle, and commencing about two

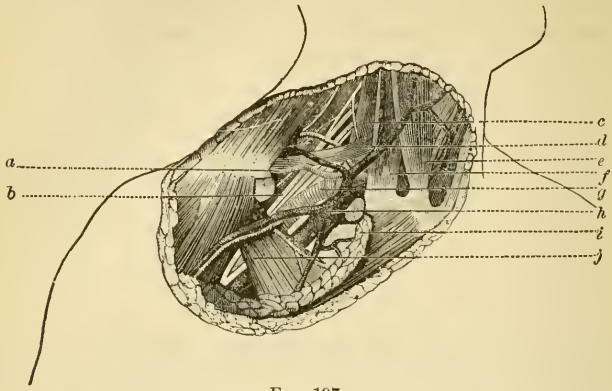


Fig. 197.

inches outside of the sterno-clavicular articulation, through the skin, platysma, and subcutaneous cellular tissue; separate the fibres of the pectoralis major gradually until the posterior investment of this muscle, like an aponeurosis, appears; now depress the shoulder and tear this fascia with the point of the director; press downwards and outwards with the finger the upper border of the pectoralis minor,

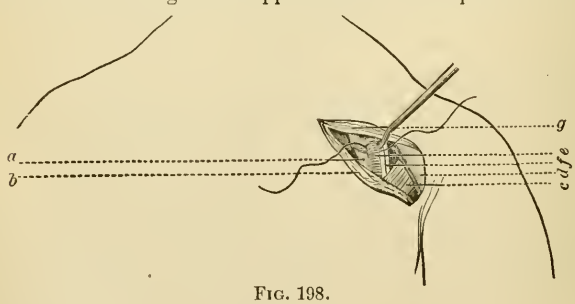


Fig. 198.

when the axillary vein is brought to view; draw this gently forward with a blunt hook, and behind it the artery is found, with the nerves of the brachial plexus still further behind and above; pass the needle from within outwards.

Or (Fig. 198), make a transverse incision three inches in length, through the skin and platysma, along and upon the lower edge of the clavicle, three fingers'

breadth from the sternal extremity of that bone, and terminating an inch from the acromion process of the scapula; make a second incision, three inches in length, obliquely through the integuments, over the deltoid and pectoral muscles, meeting the first nearly in the centre; remove the cellular membrane and fat; detach the clavicular portion of the pectoralis major, *g*, *b*, and remove the cellular tissue overlying the subclavian vessels; the artery now appears and its pulsations are detected; the pectoralis minor, *c*, and the margin of the deltoid, *d*, are brought to view, and the artery, *e*, is isolated from the vein, *a*, lying in front, and the brachial plexus behind.

(*b.*) Below the pectoralis minor, in its lower half, the artery is superficial, covered only by the integuments and deep fascia.

The coraco-brachialis muscle is in contact with the artery, which may be found at its internal and posterior border; the branches of the brachial plexus of nerves surround the artery, the musculo-cutaneous lies along the outer side; the two roots of the median meet in front, at the lower border of the pectoralis minor; the nerve then lies in front and to the outer side of the artery; the internal cutaneous lies in front and to its inner side; the ulnar and radial are still further within and behind; the axillary vein is in front of the artery and nerves, which it partly conceals.

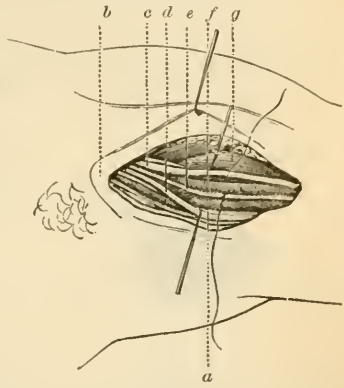


FIG. 199.

Place the patient (Fig. 199) on the back, the arm rotated outwards; stand on the outside if it is the right arm, and on the inner side if the left, and recognizing the inner border of the coraco-brachialis muscle, *g*, and the pulsations, make an incision two or three inches in length in the line indicated, *b*, dividing only the skin; incise the fascia on a director; with the end of the director, the axillary vein, *a*, is first pushed backwards, then the brachial plexus; the median nerve, *c*, is now recognized, and being brought forward, while the internal cutaneous, *e*, and ulnar, *d*, are pushed backwards, the artery, *f*, is exposed; separate the artery carefully from the vein, which is pushed backwards, and the nerves which surround it, and pass the needle from behind forwards.

3. **The brachial artery** extends from the lower margin of the axilla to an inch below the bend of the elbow, in a line drawn from the junction of the anterior with the middle third of the axilla to the middle of the bend of the elbow.

(*a.*) In the upper third, the arm being extended as before, make an incision two and a half inches in length along the inner border of the coraco-brachialis; the artery is readily exposed, lying between

and behind the median and ulnar nerves, the former to the outside, and the latter to the inside.

(*b.*) In the middle of the arm the brachial descends on the inner side, first of the coraco-brachialis, and afterwards of the biceps.

It is covered by the fascia and integuments, and overlapped slightly by the biceps; its sheath contains the two venæ comites; the internal cutaneous nerve lies superficial to it; the median is superficial to it above, and rather to its outer side; about the middle of the arm, it crosses the artery, and inferiorly it is to its ulnar side: the ulnar nerve is internal to the artery, and at some distance from it inferiorly; the spiral nerve is posterior, and separates it above from the triceps.

(Fig. 200.) The arm being extended and carried at right angles to the body, and held supine, the course of the artery may be recognized, by its pulsation; by the internal margin of the biceps and coraco-brachialis; by the median nerve, to the inner side of which it lies; by the line above given. Make an incision two or three inches in length, along the inner border of the biceps, down to the fascia, which incise on a director; the position of the median nerve, *b*, is detected in the wound; push it aside with the biceps, *d*; the artery, *c*, is found immediately behind and inside, accompanied by its venæ comites, *a*. The arm is now flexed, the vessel isolated, and the ligature passed from without inwards.

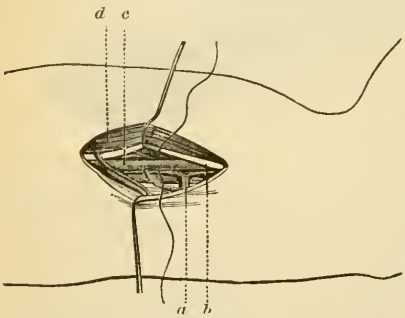


FIG. 200.

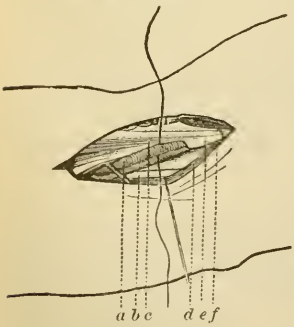


FIG. 201.

If the incision is made a little too far back the ulnar nerve is exposed, and is liable to be mistaken for the median; and this error may be confirmed by the presence of the vein, occupying the same relative position as the brachial to the median, which may be mistaken for the artery. If it is remembered that the ulnar nerve here passes downwards and backwards, the error will be rectified. The brachial may have a high division into the radial and ulnar; or it may have a high division, and the branches again unite in the arm.

(*c.*) At the elbow the brachial artery lies in the centre of a trian-

gular space, formed by the supinator longus, externally, and the pronator radii teres, internally.

It rests on the brachialis anticus; the median nerve lies to the inner side half an inch; the tendon of the biceps lies on the outer side; its coverings are the skin, superficial fascia, and the median basilic vein, which is separated by the bicipital fascia.

The arm extended and held in a supine position (Fig. 201), make an oblique incision, two inches and a half in length, along the internal edge of the tendon of the biceps, within the median basilic vein, dividing only the skin; push aside the vein and divide the aponeurosis, which is the deep fascia, *e*, on a director; the tendon of the biceps, *c*, is now seen, and on its inside the artery, *a*, with its two veins, and still farther inward the median nerve, *b*; slightly flex the forearm, and pass the needle from within outward, carefully avoiding the veins.

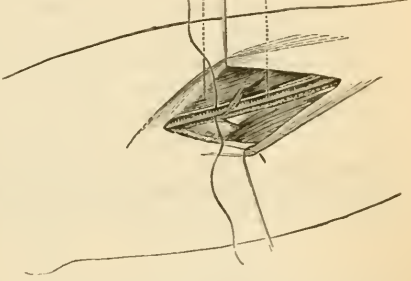


Fig. 202.

4. **The radial artery**, though the smaller branch of the brachial, lies in the direct course of the latter like a continuation; its course is marked by a line drawn from the centre of the elbow to the inner side of the styloid process of the radius; is superficial throughout nearly its entire course; the needle may be passed in either direction.

(*a.*) In the upper third the artery lies between the supinator longus and the pronator radii teres; it has venæ comites; the radial nerve lies immediately on its external side (Fig. 202). The limb being extended supine, the superficial veins made prominent by pressure of the thumb above, make an incision two to three inches in length, on the internal border of the supinator longus, if recognized by the depression, or on a line drawn from the middle of the bend of the elbow to the inner side of the styloid process of the radius, dividing the skin and superficial fascia; divide the deep fascia on a director; flex the arm slightly to relax the muscles; the supinator longus, *a*, being drawn aside, the sheath of the artery, *b*, is exposed; pass the needle from without inwards.

(*b.*) In the lower third of the arm the artery is situated superficially, lying between the tendons of the supinator longus and the flexor carpi radialis; it is accompanied by venæ comites, and by the radial nerve which lies external; its pulsation is easily detected

(Fig. 203). The arm held supine, the hand forcibly extended to make prominent the flexors, and the operator standing on the external side of the limb, make a light incision, two inches in length, from half an inch above the articulation of the radius, on the external border of the flexor carpi radialis, or on a line joining the external with the three internal fourths of the arm; the deep fascia, *a*, is raised on a director, exposing the artery, *c*, with its two veins, *b*, and the nerve, *d*, external and posterior; the needle may be passed in either direction.

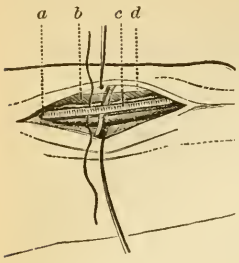


FIG. 203.

(*c*.) On the dorsum of the wrist (Fig. 204), the artery passes in the groove between the upper extremities of the first metacarpal bones; a fibrous band separates it from the tendons of the thumb. It may be tied, just as it is about to form the palmar arch, or, as it passes under the extensor muscle of the thumb, between the extensor primi internodii and the extensor secundi internodii pollicis, a little below and posterior to the extremity of the styloid process of the radius. At the commencement of the palmar arch, make an incision of an inch in length along the outer borders of the extensor secundi and metacarpi pollicis, at the angle formed by the two first metacarpal bones, care being taken not to wound the superficial veins; the artery is readily exposed. At the higher point, place the hand between pronation and supination, the thumb strongly abducted so as to render prominent the extensors, and make an incision an inch in length, between the tendons of the two extensors, commencing at the lower extremity of the radius, and in the line of the axis of the first metacarpal bone; make these incisions lightly, to avoid the superficial vein of the thumb; draw the extensor ossis metacarpi pollicis, *a*, inwards, and the extensor secundi internodii pollicis, *d*, outwards, expose the artery, *c*, and its accompanying veins, *b*.

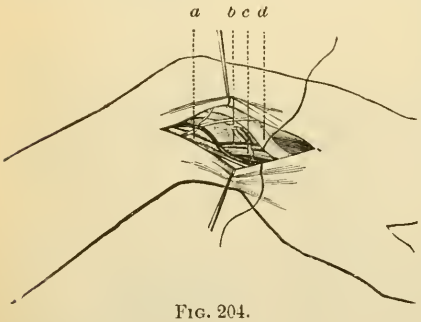


FIG. 204.

5. **The ulnar artery**, the larger terminal division of the brachial, passes to the inner side of the forearm, at the lower part of its up-

per third, continues along the ulnar side to the wrist, passes over the annular ligament, on the outer side of the pisiform bone, and terminates in the superficial palmar arch. Its course is marked by a line drawn from the internal tuberosity of the os brachii to the external side of the pisiform bone.

(*a.*) In its upper third, the ulnar artery, arising from the brachial, curves inwards deeply beneath the flexor muscles, and passes along the ulnar side of the forearm, between and covered by the flexor carpi ulnaris and flexor sublimis digitorum; it is accompanied by two veins, and by the ulnar nerve, which is more superficial and internal, and on the radial side (Fig. 205). The forearm being supine, the hand strongly extended and inclined to the radial side, make an incision on the imaginary line given, three inches in length, and beginning three fingers' breadth below the internal condyle through the skin and superficial fasciæ, and recognize the aponeurotic connection of the flexor carpi ulnaris and flexor sublimis, which is of a yellowish-white color; divide it on the director from below, where it is the most delicate, carefully avoiding the division of muscular substance; the flexor sublimis, *a*, is drawn outwards, and the deep aponeurosis exposed, under which lies the artery; if the vessel is not seen, press the flexor carpi ulnaris, *c*, inwards, and expose the ulnar nerve, *b*, a little external to which lies the artery, *e*, with its two veins, *d*; isolate the artery by flexing the arm slightly and the hand strongly; pass the needle from within outwards.

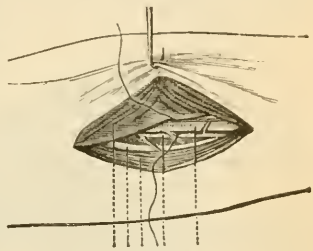


FIG. 205.

(*b.*) In the lower third the artery is covered by deep fasciæ, having upon its inner side the flexor carpi ulnaris and ulnar nerve, and upon its external side the flexor sublimis digitorum. Place the arm supine, and extend the hand so as to make prominent the tendon of the flexor carpi ulnaris; then along the radial border of this muscle, *a* (Fig. 206), or at the union of the external four fifths of the arm with the internal fifth, or on a line drawn from the internal condyle to the pisiform bone, make an incision about two inches in length, through the skin, *c*, and subcutaneous cellular tissue, *e*; raise the deep fascia on a director, or with the forceps, and incise it, exposing the tendon

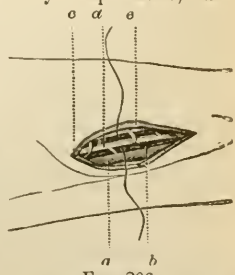


FIG. 206.

of the flexor carpi ulnaris; this should be pressed inwards, and immediately behind it the artery, *d*, will be found with its two accompanying veins, *b*, and the nerve upon the inside.

(*c*.) At the wrist (Fig. 207) the artery lies immediately to the radial side of the pisiform bone, and is accompanied by its veins, *b*, and the ulnar nerve, *c*, which lies on its internal and posterior aspect. The hand being held back, make a slightly curved incision on the radial side of the pisiform bone, through the skin and adipose tissue, about three inches in length, its concavity looking inwards; the artery, *a*, is deeply seated in a groove, and the dissection should be continued along the side of the pisiform bone until it is exposed; the latter part of the dissection will be facilitated by flexing the hand upon the forearm; pass the needle beneath from within outwards.

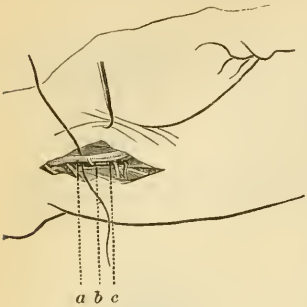


FIG. 207.

ARTERIES OF THE LOWER EXTREMITY.

Aneurisms of the arteries of the lower portion of the body, for which the ligature has been applied, now give the following indications as to treatment :[1] —

1. **Abdominal aneurism,** if of the aorta, must, as a general rule, be restricted to rest and medical measures only; some of the aneurisms affecting the lowest part of the vessel may be under the influence of pressure applied to the artery as it lies on the spine just above the origin of the mesenteric; the artery has been successfully compressed where it lies between the pillars of the diaphragm;[2] pressure is now a recognized surgical proceeding very far superior to the ligature of the aorta, but is dangerous from protracted anæsthesia, contusion of the viscera, and injury to the great sympathetic ganglia and nerves; when employed, the patient's bowels should be freed, the walls relaxed by bending, full but not deep anæsthesia produced, and the tourniquet applied.

2. **Gluteal aneurism,** if traumatic and approaching the character of a recent wound, should be laid freely open and the artery tied, the sac being plugged with the finger,[3] or the tourniquet being applied to the aorta; compression of the aorta or common iliac, galvano-puncture, or injection of coagulating fluids, are justifiable measures; if the aneurism extend into the pelvis the internal iliac may be ligated. Pressure upon the trunk of that artery might possibly be effected by the fingers, the hand being introduced into the rectum.[4]

3. **Ilio-femoral aneurism** should first be treated by instrumental pressure, under an anæsthetic, of the common iliac or the aorta; if pressure fail, resort to ligature of the common iliac. In aneurism of the common femoral the external iliac artery must be tied.

[1] T. Holmes. [2] Murray. [3] J. Syme. [4] W. H. Van Buren.

4. **Popliteal aneurisms** forming on the anterior face of the vessel, known by the distinct line of pulsation in the course of the artery lying over the tumor, are rarely cured by any other measure than the ligature, and this often fails, rendering amputation necessary. In treatment of the more common form, growing from the back, or partly from the side of the artery, marked by absence of any distinct line of pulsation, early implication of the nerve, and swelling of the foot and leg, digital or instrumental pressure on the femoral should be made; if it is very small, flexion may first be tried; if these methods fail, or if the aneurism is extending, and in all the severe forms not demanding amputation, the ligation is the safest course.

1. **The abdominal aorta** lies in front, and a little to the left side of the bodies of the vertebræ, having the vena cava on its right side, the sympathetic nerve on its left, and the left lumbar veins behind, it may be ligated about one inch above its bifurcation. It can be exposed and successfully ligated by the operation for the common iliac; the artery being separated from the vein with the finger or a direc-

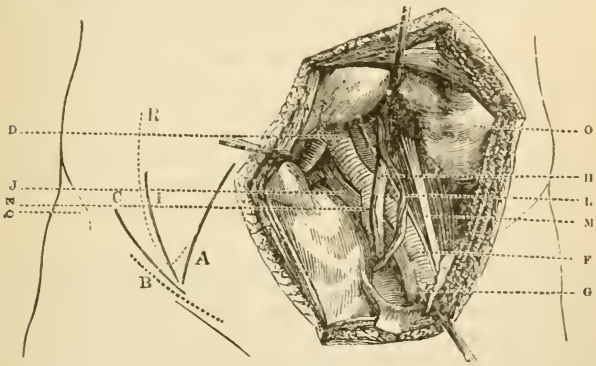


Fig. 208.

tor; pass the needle from left to right. Or, make an incision along the linea alba, three inches in length, the middle of it on a level with the umbilicus, but a little to the left; open the peritoneum; push the intestines aside; detect the artery by its pulsations, separate the peritoneal covering with the finger nail on the left side, carry the finger under the vessel, and pass the needle from left to right; [1] or, make an incision from the extremity of the tenth rib downwards six inches, curving backwards to within an inch of the anterior spine of the ilium, Q, and reach the aorta from the side by raising the peritoneum. [2]

2. **The common iliac artery** (Fig. 208) varies from three quarters of an inch to three inches in length, averaging about two; [3] it passes from the bifurcation of the abdominal aorta, on the left side of the

[1] Sir A. Cooper. [2] Murray. [3] L. Holden.

body of the fourth lumbar vertebra, a point corresponding with the left side of the umbilicus, on a level with a line drawn from one crista ilii to the other, downwards and outwards along the margin of the pelvis to the sacro-iliac synchondrosis; the artery upon the right side is on an average the same length as[1] that upon the left, and has in front, the peritoneum, and at its point of division, the ureter.

Behind, the accompanying vein, J, is partly external above, but below it lies behind and slightly internal; on the outer side, the common iliac vein above, and the psoas muscle, M, below. The left common iliac has the rectum and superior hæmorrhoidal artery in front, the left common iliac vein internal and partly beneath, and the psoas magnus external.

The patient being placed on the back (Fig. 208), inclining to the opposite side: make an incision, R, commencing just anterior to the extremity of the eleventh rib, downwards, one and a half inches within the anterior superior spine, and terminating just above the internal ring by a sharp curve upwards and inwards of an inch; the entire length is about seven inches; divide the integuments and superficial fascia; then the three abdominal muscles; cautiously raise the fascia transversalis from the peritoneum, first at the upper part of the wound where the union is slightest; now gently elevate the peritoneum and press it inwards from the iliac fossa towards the pelvis; the pulsations of the external iliac, F, are first recognized, and the finger carried upwards along this vessel reaches the common trunk; the ureter, H, in front, is carefully pushed aside, and the needle passed from within outwards.

There is great danger of lacerating the peritoneum, both in the act of separating it from the transversalis fascia, and in raising it from the iliac fossa; to avoid the first accident the transversalis fascia should be first raised high up in the wound, where the attachments are the slightest; to avoid the second, the peritoneum, with the inclosed bowels, O, should be raised on the palms of an assistant standing upon the opposite side of the patient, while the surgeon gently separates with his fingers its attachments. Other methods are indicated by the incisions B, A, C, I.

3. **The internal iliac artery** (Fig. 208), E, is an inch and a half in length, extending from the bifurcation of the common iliac downwards and forwards to the upper margin of the great sacro-sciatic foramen; it is in relation anteriorly with the ureter, H, which separates it from the peritoneum; posteriorly, with the internal iliac vein; it rests on the sacral plexus of nerves and the pyriformis muscle; on the left the rectum lies partially over it. The artery may be readily exposed and ligated by the method described in the operation on the primitive iliac;[2] or, make an incision five inches long, half an inch outside of and parallel to the epigastric artery;[3] or, make an incision in a semicircular form, commencing two inches to the left of the

[1] L. Holden. [2] Stevens. [3] White.

umbilicus, and ending near the external ring, seven inches in length, with the convexity towards the ilium.

4. **The gluteal artery** emerges from the pelvis, at the upper part of the great ischiatic notch, above the upper border of the pyriformis muscles.

Fig. 209.

It is covered by the gluteus maximus muscles, and is accompanied by two veins; a line drawn from the posterior superior spine of the ilium to the top of the great trochanter marks the course of the artery.

(Fig. 209.) Place the patient upon his belly, the thigh extended; make an incision on the line above indicated, four or five inches long; the cut is parallel with the fibres of the gluteus maximus, which should be separated, and the finger introduced to detect the pulsations of the artery; separate the pyriformis and gluteus medius muscles, the borders of which cover the vessel, and isolate the artery from its veins and pass the needle.

5. **The sciatic artery** escapes from the pelvis between the pyriformis and coccygeus muscles, and descends in the interval between the trochanter major and tuberosity of the ischium.

It is covered by the gluteus maximus, and is accompanied by the sciatic nerve, and the vein which lies to its posterior and inner side; the centre of a line drawn from the posterior superior spinous process of the ilium to the tuberosity of the ischium, marks the point of exit of the artery from the pelvic cavity.

(Fig. 210.) Place the patient upon the belly; make a vertical incision, two inches in length, the centre of which falls upon the point of emergence of the artery, as given above; divide the skin, cellular tissue, and the fibres of the gluteus maximus; the artery is found to the inside of the nerve, and must be carefully isolated from the vein.

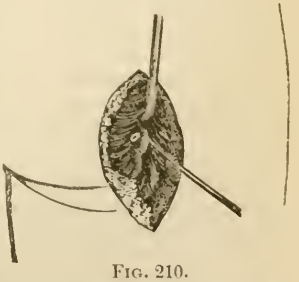


Fig. 210.

6. **The internal pudic artery**, the smaller of the two terminal branches of the internal iliac, passes out of the pelvis through the great sacro sciatic foramen, internal to the sciatic artery; it again enters the pelvis through the lesser sacro-sciatic foramen, runs along the ramus of the ischium and pubis, and divides into the arteries of the penis.

(*a.*) At the greater sacro-sciatic foramen make the same incision

as in the ligature of the sciatic artery; the pudic is found a little internal, accompanied by its veins and the pudic nerve.

Fig. 211.

(*b*.) In the perineum (Fig. 211) the artery may be ligated as it descends the ramus of the ischium; draw a line from the middle of the pubes to the internal border of the tuber ischii. The patient being placed in the position for lithotomy, make an incision two inches in length along the ramus of the pubis, near the arch; by careful dissection the vessel is found along the inner border of the ramus, where it may be isolated and the ligature applied; care should be taken not to incise the corpus cavernosum.

7. **The dorsalis penis artery** reaches the dorsum of the penis by passing between the crura, and runs forward, through the suspensory ligament, in the groove of the corpus cavernosum, to the glans, distributing branches in its course to the body of the organ, skin, and prepuce. It is enveloped in the subcutaneous layer, and is accompanied by the dorsalis penis nerve and vein; the latter structures should be remembered in ligating the artery. Make an incision three fourths of an inch in length, commencing two inches in front of the pubes directly in the median line; carry the incision through the skin and superficial lamina of the subcutaneous layer, when the artery is fully exposed; pass a small artery needle, carefully avoiding the nerve.[1]

3. **The external iliac artery,** about four inches in length, passes obliquely downwards and outwards, from the sacro-iliac symphysis to Poupart's ligament, in a line drawn from the left side of the umbilicus to a point midway between the anterior superior spine of the ilium and the symphysis pubis; it may be ligated in any part of its course, except near its upper and lower extremities.

In its upper portion it has in front the peritoneum and intestines, and near Poupart's ligament the spermatic vessels, genito-crural nerve, circumflex iliac vein, lymphatic vessels and glands; externally, the psoas magnus, M, from which it is separated by the iliac fascia; internally, the external iliac vein; below, and curving along its side, the vas deferens; behind, it rests above upon the external iliac vein, which gradually passes to its internal side.

Place the patient in a recumbent position, the abdominal muscles relaxed; make an incision three or four inches in length (Fig. 212),

[1] J. C. Hutchison.

commencing about an inch and a half within the anterior superior spine of the ilium and on a level with this process, and extending in a curved direction downwards and inwards, nearly parallel with Poupart's ligament, and terminating an inch and a half above it, just outside of the external abdominal ring; on the left side it will be found convenient to commence the incision internally, at the external ring and carry it upwards and outwards to the point indicated within the anterior superior spine; incise the integuments and fascia, and tie the superficial epigastric artery, if divided; the aponeurosis, *c*, of the external oblique muscle is now exposed and divided on a director; in the same manner divide the fibres of the internal oblique and transversalis muscles, *a*, until the transversalis fascia, recognized by its white, opaque appearance, is exposed; cautiously open this membrane and incise on the director; the peritoneum, *d*, is now exposed and carefully detached from the iliac fossa, and pushed towards the pelvis; the artery, *b*, is readily felt pulsating at the bottom of the wound, along the inner border of the psoas muscle, the vein being on the inner aspect, the genito-crural nerve external; open the sheath and insinuate the needle beneath it, from within outwards, to avoid the vein. Or, the finger may be passed into the internal ring along the spermatic cord and the iliac fascia raised in this manner.

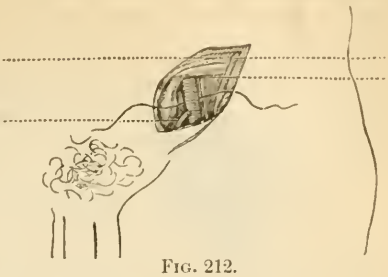


FIG. 212.

Other incisions [1] are made in the course of the artery (Fig. 208, A), three inches in length; a curved incision (Fig. 208, C),[2] commencing a little above the spine of the ilium, and terminating a little above the internal edge of the inguinal ring; an incision (Fig. 208, B),[3] in the centre of the space between the anterior superior spine, and the symphysis pubis.

9. **The epigastric artery** (Fig. 208, G), arises from the anterior face of the external iliac above Poupart's ligament.

It at first descends and then passes obliquely upwards and inwards between the peritoneum and the transversalis fascia, in a line drawn from the middle of Poupart's ligament to the umbilicus; it lies behind the inguinal canal, and to the inner side of the internal abdominal ring; it has two veins nearly to its origin.

The incisions in the last operation, but not so long, are equally adapted for ligating this artery; the spermatic cord is first sought

[1] Abernethy. [2] Cooper. [3] Bogros.

for, and being raised, the inner border of the internal ring is exposed; the ring is dilated with the end of the finger, and behind the layer of transversalis fascia constituting its border the artery is felt.

10. **The femoral artery** extends from Poupart's ligament to the tendinous opening in the adductor magnus muscle, at the junction of the middle and lower third of the thigh, in a line drawn midway between the anterior superior spine of the ilium, and the symphysis pubis, and the inner side of the internal condyle.

(*a.*) Beneath Poupart's ligament the artery is superficial, being covered by the skin, superficial and deep fasciæ, and lymphatic glands; the vein lies on its inner side, and the anterior crural nerve half an inch to its outer side; the vessels lie in a canal formed by the parting of the two layers of the fascia lata, and are separated by this septum. The pulsations of the artery being recognized, midway between the anterior superior spine of the ilium and the pubes, make an incision two inches in length, over the artery, commencing at the crural arch; divide the skin and cellular tissue; raise the fascia, *a*, on a director, and expose the sheath; open it and draw the vein, *c*, inwards, and pass the needle around the artery, *b*, from within outwards, ligating it above the profunda femoris. The incision may be parallel[1] with Poupart's ligament.

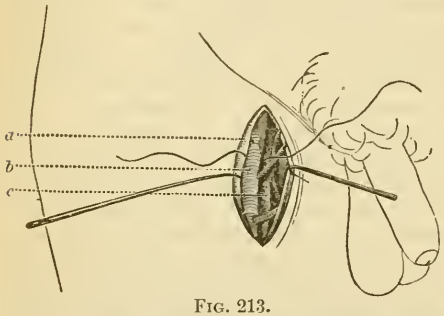


FIG. 213.

In persons of ordinary flesh, the fold of the groin corresponds exactly with Poupart's ligament, but in those who are very fleshy the fold is somewhat below Poupart's ligament: and should this be taken as the guide to the commencement of the incision there would be danger of applying the ligature just below the origin of the profunda; it is advisable to bring the ligament into view before the ligature is applied, and pass the needle a finger's breadth below.

(*b.*) At its upper portion the artery lies in a triangle, Scarpa's space, formed by Poupart's ligament above as its base, the sartorius externally, and the adductor brevis internally; it is very superficial, being covered by integument, the superficial and deep fasciæ, and lymphatic glands; the vein is on the inner and slightly posterior part (Fig. 214). Ligate near the apex of the triangle; flex the thigh

[1] Porter.

slightly on the body, abduct and place it on its external aspect; make an incision commencing about four inches below Poupart's ligament, along the inner margin of the sartorius muscle, three inches in length; the saphenous vein, first made prominent by pressure above, is left to the inner side; divide the fascia lata, *a*, expose and draw outward the sartorius, *b*, and the sheath of the vessels becomes apparent; the position of the artery is recognized by its pulsations; open the sheath to a sufficient extent to pass the needle, which is cautiously done from within outwards to avoid the vein, *c*; the point of the needle should be kept close to the artery, *d*, as the vein lies closely on its inner and posterior aspect.

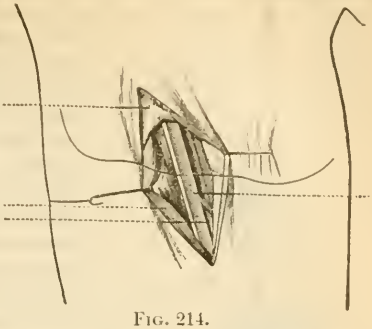


FIG. 214.

If the saphenous vein is wounded, compression is sufficient for its treatment; if the incision falls upon the sartorius, this must be drawn aside.

(*c*.) At its middle portion the artery is covered by the skin, superficial and deep fasciæ, and sartorius, and is contained in a fibrous canal; the femoral vein lies on the outer and posterior part of the artery, and the long saphenous nerve more externally. Place the limb in the position above described, and make an incision three or four inches in length at the middle of the thigh, on the line given, or on the inner border of the sartorius muscle, its upper extremity being six lines, and the lower two lines from the internal border of that muscle, care being taken to avoid the internal saphenous vein, the course of which is made apparent by compression above; expose the sartorius by dividing the fascia lata; draw it outwards; expose and divide the fibrous connection between the vastus and adductor muscles; the sheath of the vessel now appears, which is readily opened, and the needle passed from within outwards, avoiding the vein and long saphenous nerve.

(*d*.) At the inferior part of its course the artery enters a fibrous sheath, formed by the fibrous bands which extend from the vastus internus to the adductor magnus and longus, having over it the sartorius muscle, fasciæ, and integuments (Fig. 215). Flex the thigh on the pelvis, and the leg on the thigh, the limb resting on its external surface; make an incision three inches long on the outer margin of the sartorius muscle, if recognized, or on the line above given; the

skin being divided, the sartorius, *c*, recognized, and the fascia, *a*, divided on a director, two lines within its external border; draw the muscle backwards and divide the posterior part of its sheath; the space between the vastus internus and adductor magnus is now recognized, which contains the canal of the artery; open this canal, *b*, on a director, and the artery, *d*, is exposed, with the vein on its inside, and the saphenous nerve on the outside; the vessels are united by very dense cellular tissue, and great care is necessary to isolate the artery.

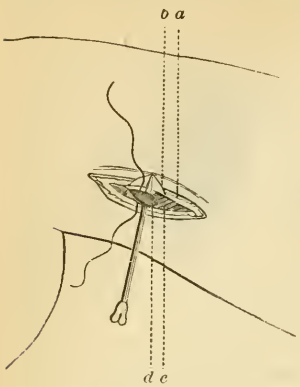


FIG. 215.

11. **The popliteal artery** extends from the opening in the adductor magnus to the lower border of the popliteus muscle, in an oblique direction downwards and outwards.

In the popliteal space the external saphenous vein runs perpendicularly in the median line, and in the middle of the popliteal space perforates the deep fascia; then ascends, winds around the popliteal nerve, and empties into the popliteal vein. It is accompanied by the external saphenous nerve, from which it is separated by a process of the deep fascia; the popliteal nerve passes down the middle of the popliteal space, beneath the deep fascia, superficial to, and on the outside of the popliteal vessels, from which it is separated by adipose tissue; it gives off the external saphenous and the peroneal nerves; the popliteal artery is covered in its whole course, and crossed at the middle of the popliteal space, by the popliteal vein, the direction of which is vertical; the artery always beneath the vein, is somewhat internal to it above, and external to it below; the vessels are covered superiorly by the belly of the semi-membranosus; below they pass between the two heads of the gastrocnemius. They are connected together, throughout their course, by dense cellular tissue, which renders their separation difficult.

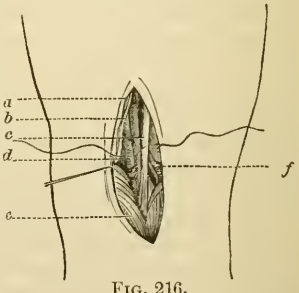


FIG. 216.

(*a*.) In its upper part; make an incision three inches in length, commencing at the inferior third of the thigh, and passing along the external margin of the semi-membranosus muscle; divide the skin and fascia; separate the cellular tissue with the director and finger: now flex the leg, and the nerve first appears, then the vein to its inside, and lastly the artery; pass the needle from within outwards.

(*b.*) In its lower part; (Fig. 216) the patient is laid on his face, the leg extended, and an incision made through the integument, three inches long, slightly on the outside of the median line; the external saphenous vein, *f*, which lies under the skin, is carefully avoided; the fascia, *a*, is divided, and the cellular substance in the space between the two heads of the gastrocnemius is separated with the finger, exposing the popliteal nerve, *c*, the vein, *b*, and most external, the artery, *d*; the nerve and vein are drawn inwards, and the needle is passed from within outwards.

(*c.*) Below the internal condyle (Fig. 217); place the patient on his back, the limb flexed and lying on the outer side; standing on the outside feel for the internal side of the muscular mass bounding the popliteal space internally and below; make an incision, *b*, two and a half inches in length, from above downwards, from without inwards, and from behind forwards, along the edge of the internal head of the gastrocnemius, within half an inch of the internal border of the tibia; care is taken to avoid the internal saphenous vein, *f*; divide the aponeurosis a little farther back than the skin; introduce the finger to break down the intermuscular septum, the leg being flexed on the thigh to relax the muscles; at the bottom of the wound is seen the nerve, *e*, to the inside, the artery, *d*, and the accompanying vein, *c*, drawn outwards.

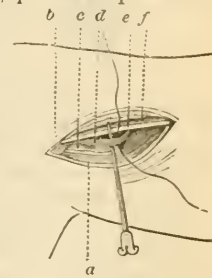


FIG. 217.

12. **The posterior tibial artery**, a branch of the popliteal artery, extends from the lower border of the popliteus muscle, in an oblique direction, from without inwards to the annular ligament; its course is in a line commencing in the centre of the popliteal space and terminating behind the internal malleolus.

(*a.*) At its upper third the artery lies very deep, being covered by the tibialis posticus, the deep aponeurosis, the soleus, and the gastrocnemius. At a distance of two thirds of an inch from the internal border of the tibia make an incision at least four inches in length, through the integuments and deep fascia; carry the index finger into the wound, detach and push outwards the internal head of the gastrocnemius, and divide also the attachments of the soleus, thus exposed, from the posterior surface of the tibia; whilst an assistant keeps this muscle held backwards and outwards with a blunt hook, divide the deep layer of aponeurosis upon a director, and search for the vessel immediately beneath; detach the artery, and pass the ligature beneath it with the artery needle.

(*b.*) In its middle third the artery lies superficial, running parallel with the inner border of the tibia, from which it is separated by the

flexor longus digitorum; it is covered by the internal border of the soleus, it has venæ comites, and the posterior tibial nerve is on its inner side (Fig. 218). The limb is placed as in the last position, and an incision made three inches in length, three fourths of an inch posterior to the internal border of the tibia; the integument and deep fascia being divided, the fore border of the gastrocnemius, *d*, is seen and drawn backwards, exposing the soleus; the fibres of this muscle should be divided on a director; the artery is now felt pulsating about an inch from the margin of the tibia; the pearl-colored deep aponeurosis which overlies is divided, and then the muscles relaxed by the position of the limb; the artery, *c*, is isolated from its veins, *b*, the nerve being pressed to the outside; the needle is passed from without inwards.

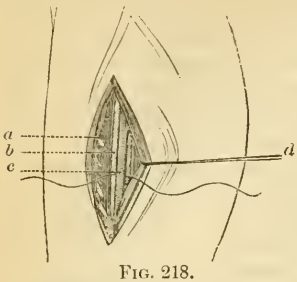


Fig. 218.

c. In its lower third, the artery passes down behind the internal malleolus, running at first parallel with the tendo-Achillis, and then midway between the internal malleolus and the tuberosity of the os calcis; it is very superficial, and is in relation anteriorly with the tendons of the tibialis posticus and flexor longus digitorum, and posteriorly with the posterior tibial nerve; it has venæ comites. (Fig. 219.) The leg being placed on its external aspect, the foot flexed, make an incision two inches in length, a finger's breadth posterior to the inner edge of the tibia, and parallel with it; the integuments are divided, the deep fascia, *a*, raised on a director, and a small mass of fat opened, which will expose the artery, *d*, and the venæ comites, *c*, and the posterior tibial nerve, *b*; the sheaths of tendons should be carefully avoided; it should be noticed that the artery sometimes lies anterior to the incision here given. The artery may be ligated a little lower by making a curved incision one third of an inch behind the external malleolus. At this part of the leg the anastomosis of large branches of the internal saphenous vein are numerous, and generally run transversely; these may be brought out by compressing the trunk of the vein above, and thus be avoided, at least in part.

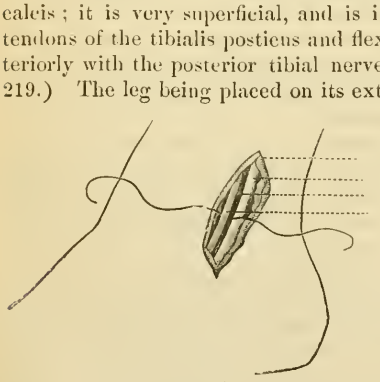


Fig. 219.

13. **The anterior tibial artery** emerges upon the anterior part of the leg, at its upper part, through the interosseous membrane, and passes down to the ankle, in a line drawn from the inner side of the fibula to a point midway between the two malleoli; it may be ligated at any point in its course.

(*a.*) In its upper third the artery lies deeply between the tibialis anticus and extensor longus digitorum; those muscles having their origin in part from the deep fascia, the intermuscular septum is not easily recognized, nor are the muscles readily separated.

The limb being turned inwards, the foot extended, take as a guide the line already given, or a point ten lines to the outer side of the spine of the tibia, and make an incision about four inches in length through the integument; divide the deep fascia with a crucial incision to allow of its complete separation; the intermuscular septum is now sought for, and may be recognized, (1.) As the first intermuscular space from the tibia; (2.) on pressure from within outwards the resistance of the other muscles; (3.) at the lower part of the wound the white line of the muscular interspace is more marked. The foot being flexed, separate the muscles with the index finger, and, the wound being held apart, expose the artery with its two veins and nerve, the latter being outside; pass the needle from without inwards.

(*b.*) In its middle third the artery is covered by the skin, superficial and deep fascia; on the inner side it has the tibialis anticus muscle, and on the external the extensor longus digitorum and extensor proprius pollicis (Fig. 220). The limb being placed as in the former position, make an incision three inches or more in length, in the course of the artery, through the integument; the septum in the deep fascia uniting the two muscles is recognized by a white line; divide it longitudinally, and also by a crucial incision; flex the foot to relax the muscles, and the wound being separated by drawing the tibialis anticus, *b*, internally, and the extensor longus digitorum and extensor proprius pollicis, externally, the nerve is met with more superficially than the artery, *d*, with its veins, *c*; pass the needle from within outwards.

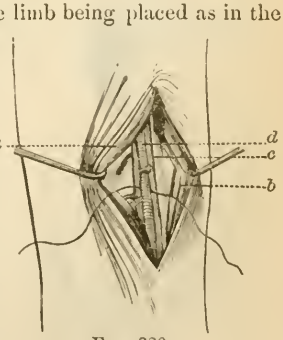


Fig. 220.

(*c.*) In its lower third the artery is covered by the integuments and fascia, and is crossed by the extensor proprius pollicis; it lies at first between the tibialis anticus muscle and the extensor proprius

pollicis, the latter muscle crossing to the inner side; the artery lies between the tendon of this muscle and that of the extensor longus digitorum; it is accompanied by venæ comites, and the anterior tibial nerve, which here lies to the outer side.

The leg being placed in a horizontal position, the foot extended, and the tibialis anticus muscle recognized, make an incision along the external border of that muscle, on the line already indicated, three inches in length, but not extending to the annular ligament; carefully incise the deep fascia on a director, and find the space between the tibialis anticus and extensor proprius pollicis, and separate the two muscles with the index finger; now flex the foot, and expose the artery, resting on the tibia with the nerve superficial to it; isolate it from the two veins, and pass the needle from within outwards, the nerve being drawn inwards. If the incision falls between the extensor proprius pollicis muscle and the extensor communis digitorum, the ligature may still be applied.

14. **The dorsalis pedis artery** terminates the anterior tibial, and runs in a line drawn from the middle of the intermalleolar space, measured from the extremities of the malleoli to the space between the first metatarsal bones.

It is covered by the integuments, fascia, and innermost tendon of the extensor brevis digitorum; on its inner side is the extensor proprius pollicis, and externally, the inner tendon of the extensor longus digitorum; it has two veins, and on its external aspect is the anterior tibial nerve.

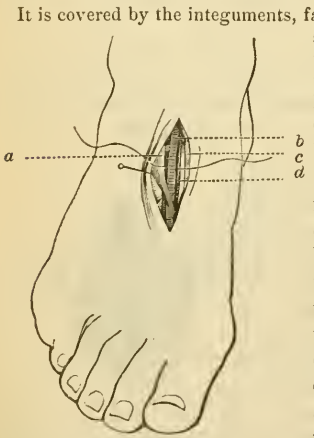


Fig. 221.

Make an incision (Fig. 221) two inches in length on the line indicated, being parallel to the external border of the tendon of the extensor proprius pollicis muscle, *c*; divide the skin and deep fascia, on a director, and draw the internal division of the extensor brevis digitorum, *a*, outwards, exposing the artery, *d*, and its accompanying veins, *b*; the nerve is on the outside; pass the needle from within outwards.

15. **The peroneal artery** arises from the posterior tibial, and runs along the inner border of the fibula to the outer side of the os calcis; its course is marked by a line drawn from the posterior part of the head of the fibula to the external border of the tendo-Achillis, at the malleolus; it may be ligated just below the middle of the leg. The

foot being extended, make an incision two or three inches long, one or two lines behind the external edge of the fibula and parallel with it; if the soleus is met with, it must be separated from the fibula and drawn inwards: the edge of the bone being now exposed, separate the attachments of the flexor pollicis proprius to its posterior surface, and the artery is found at its internal side; the muscle has a strong aponeurosis on its anterior surface, which must be divided, as the artery lies under it.

III. THE VEINS.

1. **Venesection**, or blood-letting from a vein, is performed with the thumb lancet; this instrument may have a very blunt or a very acute point; the former is preferred in operations on superficial, the latter on deep-seated veins. The patient may be seated or recumbent, but in general the position should be chosen which most enlarges the vessels; stop the flow of blood to the heart by a ligature applied around the part on the proximal side of the point selected for the operation, sufficiently firm to close the veins and still leave the arteries unobstructed; the veins now become prominent unless the person is very fleshy, when the position of the vein must be determined by its corded feel; place the thumb of the left hand firmly on the vein (Fig. 222), a little to the distal side, to prevent the vessel from rolling on the attempt to puncture it; hold the lancet between the thumb and index finger of the right hand, the blade at an obtuse angle with the hand; plunge it into the vein obliquely to its transverse diameter, and the hand being fixed, elevate the point of the lancet so as to cut its way out.

Fig. 222.

The success of the operation is determined by the flow; if this should be slight, it may be due to too small an orifice, which should then be enlarged; or to a mass of protruding fat, which may be pushed aside. If an increased flow is required, the patient should be directed to grasp repeatedly the staff, or the operator may rub the limb from the wrist towards the elbow. When the proper amount of blood is drawn, as proved by the fainting of the patient, the band should be removed, and a small compress being placed over the wound, apply a figure-of-eight bandage; to prevent air entering the circulation in bleeding from the jugular, pressure on the wound

should be made before the compress is removed. Blood may be taken from any of the superficial veins, but those of the neck, the bend of the arm, and at the ankle, are generally selected. In the neck the external jugular is preferred. Place a compress over the vein in the supra-clavicular fossa, and firmly retain it by a bandage passed over it and under the opposite axilla; place the index finger of the left hand upon the vein above, and make the incision upwards and outwards across the platysma myoides. At the bend of the elbow select the cephalic vein on account of its isolation; the basilic is the largest, but the brachial artery passing directly under it is in danger of being wounded; first determine the position of the artery, then pass a band firmly around the arm above the elbow; with his hand the patient must grasp a staff; standing in front of the patient, grasp the arm with the left hand, placing the thumb on the distended vein, and the fingers on the back of the elbow, and holding the lancet in the right, open the vessel. At the ankle select the internal saphena; first place the foot in a vessel of warm water to distend the veins, then pass a band around the leg, just above the malleoli; place the thumb on the vein, and open it just above the inner ankle, with an oblique incision.

2. **Transfusion** is the injection of the blood of one person into the blood-vessels of another to relieve extreme exhaustion. It is more useful after severe hæmorrhages when the vascular tension is slight, than in chronic diseases in which the vessels are already filled to about their natural capacity; in the latter cases, especially if associated with fatty degeneration of the heart, but a small amount of blood should be introduced at one sitting — six ounces — lest too much strain be placed upon the heart.[1] The operation is performed upon the veins, and the blood may be transferred directly from one person to another. Or it may first be drawn into a vessel and then be injected. Immerse the apparatus (Fig. 223)[2] in a basin of tepid water and expel the air by compressing the bulb; select a prominent vein at the bend of the elbow; place a bandage on the arm; raise a fold of skin over the vein; transfix and divide; seize the vein with fine forceps, and make a V incision with scissors; take the tube, *a*, from the water with the thumb over its orifice to keep it full, and insert it into the vein; the arm of the blood donor is now brought into close proximity, and the vein opened. and the tube, *b*, inserted as described; the India-rubber part of the apparatus, filled with water

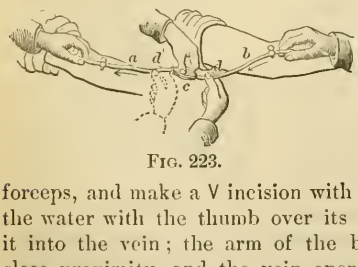


FIG. 223.

[1] J. R. Chadwick. [2] J. H. Aveling.

and kept so by turning the cocks at each end, is now fitted into the two tubes; the cocks are now opened and the injection commenced by compressing the India-rubber tube on the efferent side, *d*, and squeezing the bulb, *c*; this forces two drachms of water into the afferent vein; next shift the hand from *d* to *d'*, and compress the tube on the afferent side, allowing the bulb to expand slowly, when blood will be drawn into it from the efferent vein; by repeating this process, any quantity of blood can, at a desired rate, be transmitted, the amount being measured by counting the number of times the bulb is emptied. The blood may first be received into a vessel (Fig. 224) and then be pumped from the lower part of the cup through a canula into the veins of the patient; or the blood may be received into a vessel, if desired, and defibrinated by whipping it with a fork, and then injected with a common anatomical syringe, the blood and instruments being maintained at the temperature of 100° F.

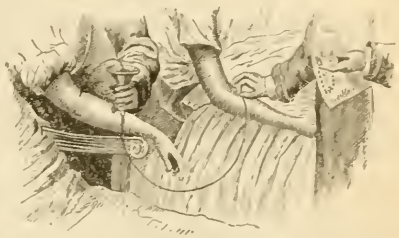


Fig. 224.

Or, isolate a subcutaneous vein at the bend of the elbow, or the large saphenous in front of the inner malleolus by a free incision through the skin and tissues, and pass under it a catgut ligature at each end of the wound; tie the distal ligature, raise the vein between the two ligatures by a small pair of toothed forceps, and with a pair of scissors directed towards the proximal portion make an oblique incision with a long flap; raise the flap and introduce the nozzle of the canula (Fig. 225) made of glass, hard rubber, or silver, and retain it in position by tying the second ligature.[1]

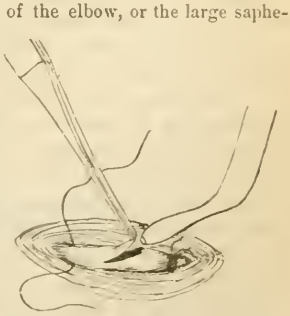


Fig. 225.

3. Intra-venous injection of milk[2] is now recognized as a perfectly feasible and legitimate procedure, not only after hæmorrhage, but in disorders which greatly depreciate the blood, as cholera, pernicious anæmia, typhoid fever;[3] it is infinitely easier than transfusion, and any one at all familiar with surgical operations may practice it without fear of great difficulty or failure: the instrument required is a glass funnel with a rubber tube attached to it, ending in a very small canula; the milk should be removed from

[1] F. Esmarch. [2] E. M. Hodder. [3] T. G. Thomas.

a healthy cow within a few minutes of its injection, and may be received into a warm pitcher covered with carbolized gauze, through which it is strained; open the median basilic or cephalic vein by a V incision (Fig. 225) introduce the canula, and allow the milk to flow in; not more than eight ounces should be injected at once. It is commonly followed by a chill as in transfusion, and rapid and marked rise of temperature, then all subsides and great improvement shows itself in the patient's condition.

IV. THE CAPILLARIES.

Local blood-letting is the withdrawal of blood from the capillaries of a part to relieve the congestion of organs or tissues. The seat of operation must, therefore, be selected with great care to obtain its full benefit. The exact area of arterial and venous distribution must be made out in each case, and blood should be taken at that point where the vessels are most nearly and readily reached; as the mastoid process, for the sinuses, in congestion of the eye, ear, or base of the brain; the angle of the jaw for the veins of the tonsils and pharynx in tonsilitic and pharyngeal inflammation; the thyroid body for the plexus of veins in congestions of the face, neck, and heart; the intercostal spaces for the arteries and veins in pleurisy; the third, fourth, and fifth, left intercostal spaces for the internal mammary vein in pericarditis; the abdominal wall in peritonitis; the anus for the portal veins in inflammation of the viscera of the abdomen; the spermatic cord for orchitis; the regions of the joints for arthritis; the surface of limbs for periostitis.

1. **Leeching** is local blood-letting by the application of leeches; a good leech is estimated to draw ℥ij, and ℥ss. more will flow if fomentations are employed. Select active, healthy, Swedish leeches, and remove them from the water an hour before their application; cleanse the part to be leeched of all irritating matter, and hairs, and smear the surface with milk; place the leeches in a leech-glass, or in a tumbler or similar vessel, and invert it upon the part; if it is desirable to apply a leech accurately to a limited space, as in the angle of the eye, the internal part of the nose, mouth, vagina, a leech-glass, or tube made of card-board, or other similar material should be used to hold the leech and fix its attachment; avoid the upper eyelid and require the recumbent position for some time to prevent ecchymosis of parts about the eye; use the speculum in applying leeches to the os uteri, and bring the neck well into its cavity; plug the os with a pledget of lint to prevent the escape of a leech into the uterus; if the leech does not drop after being filled apply salt to the body. To promote the flow from leech-bites apply warm moist dressings, as wet flannel cloths, or poultices; to arrest bleeding,

apply a dry cloth, sponge, or picked lint, with pressure, or touch the bite with nit. arg. or persulph. ferri; in extreme cases pass a threaded needle through the cellular tissue under the bite and wind the thread firmly around under the needle.

The artificial leech is a tube one eighth of an inch in diameter, having a cutting edge at one extremity (Fig. 226): it is wound up by the button, *a;* pressure at *d* releases the spring, and the cutting edge, *c*, cuts circularly to the requisite depth as fixed by *b;* to this cut apply a light glass tube (Fig. 227) from which the air is expelled by a few drops of ether poured into it, and then immersed as far as the mouth in hot water until the ether boils briskly. Each tube will draw about two ounces of blood; for uterine practice they are made long enough to be applied through a speculum.

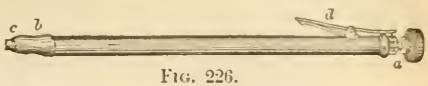


Fig. 226.

Fig. 227.

2. **Scarification** is a form of local blood-letting by incising the capillaries of the inflamed part, as in inflammation of the skin, the subcutaneous connective tissue, the tongue, the conjunctivæ. Select a sharp lancet, or knife, and make incisions on the part of greater or less length and depth, according to the seat and extent of the congestion; fomentations will continue the flow of blood; if the bleeding is too free or long continued, use lint and pressure, if necessary, externally, and persulph. ferri, if the incisions are in cavities.

3. **Cupping** is a method of abstracting or withdrawing blood from an inflamed part by creating a vacuum in a vessel applied to the neighboring integument, with or without incisions; the former is wet, the latter dry, cupping. Wet cupping requires the scarificator, the cup, and spirit lamp. The scarificator (Fig. 228) has a number of lancets whose protrusion beyond the face of the case is adjustable; these are set in a retracted position, and simultaneously discharged by a pull on the catch. The cup is a small glass or metallic cup, having a smooth mouth. Apply the scarificator in wet cupping; moisten the internal surface of the cup with alcohol,

Fig. 228.

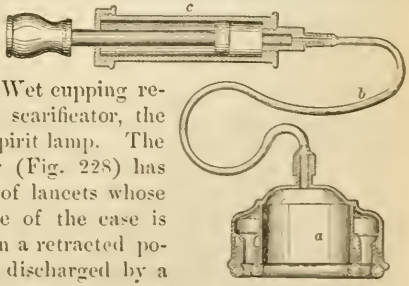


Fig. 229.

and by means of a wisp of paper, or rag, wet with alcohol, on a stick, set fire to the alcohol in the cup, which should be instantly inverted over the scarifications on the place selected; the vacuum created by the burning alcohol causes the integument to rise in the cup and thus the blood is forced out of the capillaries in wet, and stagnates in dry, cupping. The cup may have a suction-pump attached (Fig. 229); the receiver *a* is connected by a flexible pipe *b* with the nozzle of an ordinary syringe *c*; the sides of the concentric chamber afford an extended bearing for the cup, and prevent its being driven into the integument by the pressure of the atmosphere. The cupping apparatus may have a lip attached to the glass cylinder suitable for application to the skin, or to the nipple when used as a breast pump (Fig. 230); a central rod *a* has a disk with lancets which act as scarifiers, and the air is exhausted from the cylinder by means of a piston in the tube *b* attached; the air pump may be used as a syringe when detached from *c*, the blood receiver. In a very portable cupping-instrument (Fig. 231) the glass has an elastic bulb *b* by which the partial exhaustion is effected, and has also an adjustable disk provided with puncturing points to lance or irritate the skin. The scarifier, cup, and suction, may also be combined in one instrument (Fig. 232), where exhaustion being first produced in *g*, the needlebar, *b*, is thrust down, forcing the needle, *k*, into the integument, the spring returning the needle-bar and disk to position. In emergencies, scarifications may be made with the lancet or knife, and common cups or small table-glasses may be used.

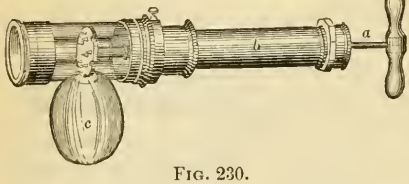


Fig. 230.

Fig. 231.

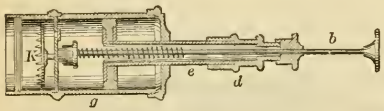


Fig. 232.

V.

THE NERVOUS SYSTEM.

THE BRAIN; THE SPINAL CORD; THE NERVES.

CHAPTER XXIV.

INJURIES OF THE NERVOUS SYSTEM, AND SPECIAL OPERATIONS.

Inclosed within the skull and the vertebral canal, the cerebro-spinal axis is protected by the bony walls of those two cavities; it is surrounded by (1) a dense fibrous membrane, the dura mater, placed most superficially; (2) a serous membrane, the arachnoid; (3) a highly vascular membrane, the pia mater; these two parts, the encephalon and spinal cord, are continuous structures.[1]

I. THE BRAIN.

1. **Concussion,[2] or violent commotion of the brain,** may cause slight and temporary effects, or may produce irreparable organic change in its structure without palpable laceration or contusion of any particular part. The symptoms are usually mixed with those due to other complicating injuries; so far as the symptoms of concussion may be isolated, the milder forms present the general indications of shock, manifested by giddiness, confusion of intellect, tottering gait, functional disturbance of the senses, sympathetic irritability of stomach, and fall of temperature. In fatal concussion, death occurs from shock rather than from direct injury to the brain. The treatment must always be directed with reference to the possible complication of fracture; perfect quiet is always necessary; if the shock is severe, stimulate the skin by frictions, warmth, mustard paste; apply ammonia to the nose, and if necessary give small doses of brandy; avoid too great reaction; when it occurs, moderate its effects upon the brain by shaving the head and applying ice; if no

[1] Quain's Anatomy. [2] F. Le G. Clarke.

complications appear, continue rest and freedom from all mental disturbance for from one to four or five weeks, according to the severity of the shock.

2. **Contusion, or bruising, of the brain**[1] occurs in many cases of concussion; the blood may be found extravasated in circumscribed patches, or these spots may be disseminated throughout various parts of the cerebral mass; bruising is far more frequent on the under than the upper surfaces of the cerebrum and cerebellum, and seldom occurs in the pons or medulla oblongata; it is rarely limited to the region of injury; in fissure the bruised part is frequently far away, or opposite the seat of the blow. The lesion is marked by no characteristic signs; contusion may legitimately be inferred whenever the symptoms are severe after injury of the head. It is always a grave accident, chiefly from the liability to inflammation of the surrounding substance immediately or remotely. The treatment is prevention of inflammation, and in detail the same as is required in concussion.

3. **Compression of the brain** is that condition which exists when pressure is made on the cerebral mass to such an extent as to diminish or obliterate its functions. The symptoms of well-marked compression are those of apoplexy, the pulse has a slow and full beat, the pupils are fixed and generally dilated, and voluntary movement and sensation are partially or entirely suspended; there is stertor, paralysis of the sphincters; the temperature, which is no measure of the amount of lesion of the brain, may fall to 94° F. or 93° F., and recovery follow.[2] The cause of the compression may be depressed bone, when the symptoms will immediately follow the injury; or extravasated blood, when the symptoms will gradually supervene; or a collection of pus, which is always preceded by inflammation; or, finally, compression by bone and extravasation of blood within the brain from laceration may coexist.[3] The precise seat of compression may be determined in cases of compound fracture with depression, with the probe or finger, and also the exact amount of depressed bone may be defined. If there is no external injury, the special nerves paralyzed must be the guide to the point of pressure; but this symptom has only a general significance and value owing to the extent of internal injury which usually exists. If there is right hemiplegia, compression is usually on the left hemisphere; but at what precise point it may be impossible to determine by any peculiarity in the paralysis.[4] The treatment aims at the removal of the cause of compression. If the cause is unknown, and the seat of pressure cannot be satisfactorily made out, direct perfect quiet; apply cold to the head to prevent inflammation, and give saline cathartics to

[1] P. Hewitt. [2] F. Le G. Clarke. [3] T. Holmes. [4] E. Brown-Séquard.

promote absorption; sustain the strength, and depend upon time for recovery. If there is depressed bone, or if there is evidence of extravasation of blood between the bone and dura mater at the seat of injury, proceed at once to trephine.

4. **Wounds of the brain and membranes**[1] may be punctured, cut, or lacerated; these lesions are not necessarily fatal, though as a rule they are; death may ensue without reaction, or after inflammation is developed. The symptoms, when unaccompanied by pressure, are frequently not developed until inflammation ensues, and therefore the diagnosis is necessarily obscure; or the nature of the lesion may be overlooked until there are indications of brain disturbances, after an interval of three or four days, or longer. Examination with the finger or probe determines the nature, and partially the extent, of the injury. The treatment is designed to prevent inflammation and its consequences. The hair should be shaved, fragments of bone or foreign matters lodged in the wound removed, and, if necessary, the wound must be enlarged by the trephine; having thoroughly cleansed and disinfected the wound, bring the integuments together and retain them with adhesive or elastic plaster; apply ice-bladders; enjoin perfect quiet, with saline cathartics, and low diet. If inflammation follows, the brain is liable to protrude at the wound, creating a hernia cerebri, and abscess may form.

5. **Fissure of the skull**[1] accompanying scalp wound, but unattended by brain disturbance after subsidence of the shock, is not infrequent; fissure may be detected through the wound, though there is no displacement; or there may be inequality of the line of fracture, indicating some depression, without brain injury. These cases require the treatment for concussion, with long continued abstinence from any and every source of excitement.

6. **Fractures and fissures**[1] which extend to the base of the skull are diagnosed with difficulty. Ecchymosis in the mastoid region, or the pharynx, or the eye, are rare and uncertain signs; pharyngeal extravasation is most important; when ecchymosis appears first, some thirty-six hours after the injury on the ocular conjunctivæ, and spreads to the lids, it is pathognomonic of this form of fracture; the oozing of blood and serum from the ear is diagnostic of fracture of the petrous bone only when limpid fluid is supplied in abundance, and contains an excess of chloride of sodium; paralysis of the facial and auditory nerves is only a suspicious symptom, and must be taken in connection with the other evidences, for it may result from inflammation or pressure. The treatment is long-continued rest, low diet, saline cathartics.

[1] F. Le G. Clarke.

7. **Fracture of the skull**[1] is of comparatively little importance, except so far as it is accompanied by, or entails as a sequence, mischief to the brain; therefore, as a general principle, the presence of fracture, unattended by cerebral symptoms, rarely demands or justifies interference. The treatment which fractures ordinarily require is simply rest, cold to the head, saline cathartics, and low diet for many days. Those fractures which demand especial attention, owing to cerebral complications, are: (1) depressed fractures, simple and compound; if the simple, depressed fracture is without symptoms of compression, do not interfere with it, but treat the case as one of concussion; if the symptoms of compression are present, proceed at once to raise the bone; if the compound depressed fracture does not cause compression, do not interfere unless there are evidences by the probe that sharp fragments are driven down upon the meninges, when they should be very cautiously elevated, or, if loose, removed to prevent subsequent inflammation; (2) penetrating wounds which splinter the internal table; the danger of these wounds lies in the subsequent inflammation which the bone excites; although trephining is often practiced as a preventive measure, the results are not favorable, and the wiser course is not to interfere unless symptoms of irritation or compression supervene.

II. THE SPINAL CORD.

Accidents to the vertebral column derive their chief importance from endangering the spinal cord; certain portions are more frequently the seat of injury than others, namely, the dorsi-lumbar, the cervico-dorsal, and the atlo-axial.[2]

1. **Concussion of the spine** often develops symptoms of the most serious, progressive, and persistent character, not only after apparently slight injuries, but frequently when there is no sign whatever of external injuries.[3] It occurs usually as the result of a fall on the nates or back; the shock is generally not severe, even when the paraplegic condition is well marked; the effects may be immediate, or may not supervene for some time.[1] In direct, severe injury, the primary symptoms vary with the place of injury, the force, and the amount of organic lesion of the cord produced; a blow on the upper cervical region may cause instant death, and on the dorsal region complete paraplegia; or there may be paralysis of motion, loss of power over the sphincters, alkaline urine, lowering of temperature of paralyzed parts. The secondary symptoms are usually those of development of inflammation in the meninges; namely, pain in some part or parts of the spine, increased by pressure and motion, and extending around the body, or down the limbs.[3] In the severest

[1] F. Le G. Clarke. [2] A. Shaw. [3] J. E. Erichsen.

forms there are lesions which give rise to hæmorrhage within the canal, and consequent paralysis; usually the blood proceeds from lacerations of the venous plexuses, and collects on the outside of the cord and its membranes, and in largest quantities behind and at the sides; in lesion of the cord itself the hæmorrhage is slight, owing to the small size of its vessels. In railway injuries, general shock is often, but not always, in excess of that which accompanies simple concussion; the collapse may be great, with insensibility, but without evidence of injury to the head; other symptoms are numbness and tingling, rigor, continued sickness, excito-motor spasm in the limbs, violent throbbing sensations, a sense of heat and cold in the head or other parts, want of sleep or continued drowsiness, confusion of intellect, enfeebled muscular power, deafness, defective sight with ocular spectra, hyperæsthesia in some parts, especially in the spine, great emotional excitability; with rare exceptions, there is extreme sensitiveness of the spine, more frequently located at some particular part.[1] In some cases entire recovery follows after a longer or shorter interval; in others the health is permanently enfeebled, and a life of protracted discomfort is entailed, or the sufferer sinks, emaciated and exhausted, into a premature grave, or becomes the victim of an acute disease.[1] The early treatment must be complete and absolute rest on a couch, in a prone position, rather than the supine, to avoid pressure on the back and relieve passive venous congestion, with dry cupping on either side of the vertebral column, and ice-bags, if comfortable; the secondary symptoms must be treated by continued rest and such counter-irritants as mustard poultices, stimulating embrocations, and, finally, setons and issues; when subacute meningitis begins, bichloride of mercury, in tincture of cinchona, is most beneficial; at advanced periods the iodide and bromide of potassium, in full doses, are useful; when inflammation has subsided and paralysis remains, strychnine, galvanism, and warm salt-water douches are required.[2]

2. **Twists, sprains, or wrenches of the spine**, without fracture or dislocation of the vertebræ, may occur in a variety of ways.[2] They usually result from violent bending and twisting of the column, and the force is chiefly expended on the joints and their ligaments; in the cervical and lumbar regions the impulse is broken and dispersed, owing to their mobility and elasticity; while in the dorsal region they have the character of a jar or jolt, owing to its rigidity.[3] They are most liable to occur in the more mobile parts of the column, as the neck and loins, and less frequently in the dorsal region; the head is frequently forcibly thrown forwards and backwards, moving as it were by its own weight, the patient having momentarily

[1] F. Le G. Clarke.. [2] J. E. Erichsen. [3] A. Shaw.

lost control over the muscles of the neck; the lumbar spine is often strained, with or without similar injury to the cervical portion of the column; the pain closely resembles that met with in any joint after a severe wrench of its ligamentous structures, but is peculiarly distressing in the spine, owing to the extent to which fibrous tissue and ligament enter into the composition of the column; there is aching pain in the articulations, greatly increased on pressure and motion of any kind to and fro, and especially by rotation; the spine is rigidly inflexible, the patient being unable to stoop.[1] If the sprain has lacerated the membranes of the cord, extravasation of blood follows, with gradually increasing paralysis.[2] The recovery depends upon (1) the extent of stretching of muscles and ligaments; (2) the extension of the inflammation excited in and about the articulations to the interior of the spinal canal; (3) the immediate injury to the cord and its coverings. In the most favorable cases recovery may be complete in a few weeks or months. But it often happens that the apparently slight injuries finally become serious, and hence the occurrence of a lengthened interval between the infliction of the injury and the development of spinal symptoms is unfavorable, as it indicates progressive structural change.[1] If the vertebral column is so weakened as to require artificial support for several months to enable it to maintain the weight of the head, it will probably never regain its normal strength and power of support.[1] When extravasation of blood takes place from the rupture of vessels without other injury of the cord, absorption may in time be so complete as to relieve the paralysis. The hopeless cases are those in which chronic inflammation has gone on to the development of atrophy, softening, or other structural changes, of the substance of the cord.[1] The treatment must depend upon the conditions observed in each case, but in general the remedial measures are the same as in concussion; namely, long-continued rest and efforts to prevent or subdue inflammation.

3. **Fractures of the spine**[2] derive their chief importance from their relations to injuries of the cord. Wherever the column is broken from the occiput to the second lumbar vertebra where the medulla spinalis terminates, the cord partakes of the injury, and all of the body below the fracture at once loses, more or less completely, both motor power and sensation, and hence the higher in the spine the fracture occurs the graver will be the consequences; owing to the small size of the medulla, both the motor and sensory tracts of the cord are generally deprived of their functions simultaneously; the extent of the injury to the cord may vary from the slightest lesion to a complete rupture, the degree depending upon the violence applied. When the cord is severely injured the symptoms are those of general

[1] J. E. Erichsen. [2] A. Shaw.

shock to the nervous system; at first there is profound collapse; on recovery, pain is severe at the seat of injury, especially on motion; there are irregular projections and depressions in the processes of the vertebræ; paralysis of the whole body below the level of the fracture; the urinary bladder becomes distended from paralysis of the muscles; the fæces are retained, or pass involuntarily. These symptoms will be modified, according to the locality of the fracture, as follows: below the second lumbar vertebra there may be an absence of paralysis and complete recovery; between the second lumbar and tenth dorsal, the paralysis is more often partial, motor power being lost while sensation remains, and recovery is very frequent; between the tenth and fourth dorsal the cord is more likely to be crushed through its whole thickness, owing to its small size, followed by imperfect respiration, complete paraplegia, finally, bed-sores and exhaustion; between the second dorsal and fifth cervical, the cord will more likely be crushed and broken down in its substance than compressed, the body below is paralyzed, the respiration becomes more and more embarrassed, through paralysis of the intercostal and abdominal muscles, and death ensues in five to eight days; if at the fifth or fourth cervical, the upper extremities are included in the paralysis, and death may be expected within a few hours; if the fracture occur above the level of the fourth cervical, with crushing of the cord, instant death will ensue, as the function of the phrenic nerve is destroyed. The treatment should at first aim to protect the cord from further injury; guard against motion of the spine in transportation by placing the patient on a firm support, as a door or shutter; if the neck is fractured, steady the head by sand-bags; cut off the clothes, and if there is much projection, gently stretch the body, as but slight change in the position of the patient is all that is needed, and when laid flat on his back the parts tend of themselves to come into correct apposition; the bed should be selected with a view to protect the back and hips from undue pressure, and prevent all motion of the spine; the water-bed is the best, and next, a narrow, low one, with boards instead of sacking, and two or more elastic, yet firm, horse-hair mattresses, covered by rubber cloth; provision may be made to allow the escape of urine and fæces into a receptacle under the bed by the use of rubber drawers, having a tube passing through the bed to the vessel below;[1] draw off the water with a full sized catheter, and repeat the operation twice daily, washing out the bladder with tepid water slightly acidulated with nitric acid; the greatest care should be taken to prevent bed-sores by keeping the bed dry and relieving pressure by pillows, pads, and rugs for the hips; if they form, they must be cleansed with carbolic solutions,

[1] Bradley.

and protected from all irritants; such remedies as leeching and trephining the spine are to be discarded. If convalescence follows, it will be protracted, and may often be aided by a suitable apparatus.[1]

III. THE NERVES.

Nerves, like other tissues, are subject to lesions from physical agencies, which may act without breaking the skin, simple lesions, or may involve the integument; the latter nerve wound is less grave than the former.[2]

1. **Contusion of nerves**[2] is a common incident of civil practice; as a rule, a blow with any blunt instrument over the length of a nerve is unlikely to be serious; but in the same injury to a nerve at its exit from a bony foramen, or where it rests in a furrow of bone, or lies superficially on the prominence of a joint, the consequences may be much more severe; a frequent cause of contusion of nerves is the dislocation and reduction of bones, especially at the shoulder-joint, where the nerves are liable to be bruised by being pressed between the head of the humerus, the first rib, and clavicle. When violent contusions do not cause immediate symptoms of loss of function, numbness and tingling may succeed to the first shock of pain, and only after a time be replaced by grave troubles, due to changes in the bruised nerve. When contusion is followed in a few days by slight numbness and prickling associated with growing tenderness over the nerve track, prompt treatment is necessary, as there is a commencing neuritis, or of a sclerotic state which may or may not be of inflammatory origin; the nerve may sometimes be felt in thin persons as a firm cord; in some cases the evil is most insidious, and may result in large functional losses without any notable pain or tenderness. The proper treatment for a contused nerve is absolute rest, with the use of leeches and cold water when symptoms of neuritis are present; apply three or four leeches twice weekly along the nerve, and cold continuously, unless disagreeable to the patient; inject morphia if the pain is severe; later, opium plaster along the nerve is useful, and if pain is intermittent give quinine or arsenic.

2. **Compression of nerves**[2] by external and internal causes is frequent, as by cicatrices, callus, tumors, parturition, fæcal accumulations, malposition during sleep, use of a crutch; the effect of pressure upon a nerve is to disturb the contents of the nerve tubes in such manner that impressions are no longer conveyed until the pressure is removed and the continuity of the contents of the nerve tube is restored. The symptoms are, (1) delusive impressions, as formication, prickling, sense of warmth; (2) a seeming return to the normal condition and feelings; (3) hyperæsthesia, all the func-

[1] E. D. Hudson. [2] S. W. Mitchell.

tions exalted, muscular power unchanged; (4) anæsthesia and muscular palsy, preceded by a sense of roughness of the skin, burning, muscular weariness, vague cramps. When the pressure is removed recovery takes place in a reverse order; (1) there is first pain, tickling, sensibility; (2) sudden sense of cold and feeling of enormous weight; (3) awkward motions, with formication; (4) regular motions and sense of heat. The treatment consists in removing the cause, and meeting the inflammatory symptoms with the remedies directed in cases of contusion.

3. **Wounds of nerves** [1] may be incised or punctured. The incised wound is caused by severe cuts, as with a knife, or glass. It is of great importance to make out first the extent of injury, and this may be done by examining as to the local paralysis. If the nerve is partially divided, cleanse the wound of all foreign matter with carbolic solutions; close it with sutures or adhesive strip; place the limb in a position to relax the tissues and approximate the cut ends; enjoin perfect rest; apply cold. Where it is plain that the nerve trunk has been altogether divided, the silver wire suture may be used to approximate the extremities; it should be inserted near the cut surfaces, or through the loose tissue related to its sheath; the wound should then be accurately closed; the restoration of function takes place only after long periods. Punctured wounds of small branches are more serious than of large trunks; they follow the use of the lancet as in venesection and vaccination, or other penetrating instruments. The symptoms are acute pain in the track of the nerve immediately or very soon, gradually increasing in severity until spasms or convulsions occur; slight injuries of the digital nerves seem especially prone to occasion distressing symptoms, and wide-spread reflex sympathies. The treatment is complete division if practicable; rest and cold to prevent inflammation; hypodermic injections of morphia to relieve pain.

CHAPTER XXV.

DISEASES OF THE NERVOUS SYSTEM AND SPECIAL OPERATIONS.

I. THE BRAIN.

1. **Inflammation** [2] **within the cranium** may follow any injury to the head; the brain alone may be involved, or the membranes, and even the bone. Inflammatory softening is rarely met with in the central white portions of the brain, but the cortical substance is frequently inflamed, as the result of injury to the bone, and meningitis,

[1] S. W. Mitchell. [2] P. Hewett.

which supervenes after concussion; the inflamed gray matter becomes of a dark-red hue, is swollen and soft; effusion takes place in the pia mater, and the gray matter becomes of a darker color and diffluent; this softening is frequently very extensive, the white matter remaining unaffected. There are two kinds of traumatic inflammation of the membranes; one commences in the dura mater and almost always reaches the free surfaces of the arachnoid; the other, commencing in the pia mater, seldom passes beyond this membrane unless the inflammation is very severe. When the inflammation spreads inwards from an injury of bone or of its coverings, its progress may be traced, as it were, layer by layer, from the outer parts down to the brain, involving first the dura mater, then the parietal and visceral arachnoid, the pia mater, and ultimately the cortical substance of the brain. In suppuration of the bone the outer surface of the dura mater is covered with lymph or pus, its tissue becomes infiltrated, and sloughing may follow; the mischief is generally confined to that part of the membrane directly under the diseased bone, but it may spread along the cellular tissue around the meningeal arteries, and thus reach even to the base of the skull. When this inflammation reaches the arachnoid it becomes wide-spread, and the cavity of this membrane becomes filled with a puriform exudation of a yellowish-green color, extending sometimes over one and occasionally over both hemispheres, but not to the base. From the arachnoid the inflammation spreads to the pia mater, where it is followed by a similar exudation. The cortical substance corresponding to the inflamed pia mater, is often of a dark leaden hue, soft and easily torn; the white substance is simply congested. The symptoms of traumatic intercranial inflammation are progressive, as follows: (1) Pain in the head, more or less intense, confined to the seat of injury or spreading over the whole head, fever, contraction of pupils, intolerance of light and sound; (2) disturbance of the brain-functions, restlessness, constant tossing about, convulsions, delirium; (3) drowsiness, oscillation and dilatation of pupils, twitchings and spasms of muscles, coma, relaxation of sphincters, paralysis; (4) rigors, indicative of suppuration. It cannot, however, be accurately decided what tissues are involved in the inflammatory process, nor whether pus has formed. The treatment should be decided upon after examining the different viscera, especially the kidneys; in general, secure rest and quiet in a dark room; shave the head, elevate it, and apply ice or the cold douche; give repeatedly saline purgatives; venesection is very rarely required, but leeching the temples is often useful; blisters may be applied in late stages; bromide of potassa in twenty to forty grain doses may be necessary to secure quiet and sleep; opium should not be given unless other anodynes fail.

2. **Abscess of the brain** follows injury, either from an inflammation excited by the increased vascularity of the tissues and the absence of any escape for disorganized tissue and the superfluous products of the reparative process, or by the penetration of the inflammation from the external injury through the intervening tissues; in the former case the abscess forms in the interior of the brain, and in the latter between the bone and dura mater.[1] The formation of pus is usually, but not invariably, indicated by a well-marked shivering fit, in intercranial inflammation; coma or compression may not follow, as brain abscess is usually devoid of any new element in its ingredients,[1] but if the pus is between the bone and dura mater, symptoms of compression generally appear. The treatment when abscess is declared, as by symptoms of compression, is trephining; the point of operation should be the seat of previous injury, which may be marked by a puffy swelling of the scalp; when the bone is perforated, if pus is not found, and the dura mater bulges into the hole, giving evidence of the existence of pus beneath this membrane, divide the dura mater; if pus is still not discovered and there is good reason for believing that a cerebral abscess exists under, or in the neighborhood of, the part perforated, the brain may be punctured or incised.[2]

3. **Hernia cerebri** is the protrusion of brain matter, or the products of inflammation, through openings in the bone and meninges; it may follow fractures or trephining. It is mainly due to inflammation of the brain and to the effusion of serum and pus; the cerebral substance around the place of protrusion is congested, swollen, œdematous, and soft; abscesses frequently form in the hemisphere involved, and large effusions of various kinds fill the ventricles; the mass rises out of the opening like a mushroom, and often partially sloughs away. It may terminate in recovery, gradually wasting away, but in the majority of cases the patient sinks sooner or later. The treatment is that of an inflammation: remove all sources of irritation: secure rest and quiet; preserve perfect cleanliness by syringing with weak, cold carbolic solutions; dust the dry surface with oxide of zinc or alum; severe pressure, caustics, and the knife are injurious.

4. **Hydrocephalus** is an effusion of fluid internal or external to the ventricles, and may be congenital or acquired; the former being due to malformation, the latter, to meningeal inflammations. In the congenital form, well marked, the effusion is into the ventricles; as the fluid increases the pressure from within gradually unfolds the convolutions, and thus expands the cranial arch; the base may undergo little change, but the frontal, parietal, and occipital bones are expanded in all directions, and become much thinner; the hemispheres

[1] F. LeG. Clarke. [2] W. Detmold; P. Hewett; L. Holden.

are spread out in thin laminæ on either side, decreasing in thickness from the base to the vertex: the membranes do not usually undergo any alteration except such as arise from distention. If the eyes have a persistent and characteristic downward direction, it is due to a change in the orbital plates of the frontal bone. In the acquired form, the effusion is over the surface of the brain, in the subarachnoid spaces, or in the lateral ventricles; it generally comes on after consolidation of the bones, but may appear very early and assume the conditions of the congenital variety. Operative interference is of two kinds, namely: compression and tapping. They are opposite measures, and adapted to different and opposite conditions of the brain; the one repairs defect of pressure, the other relieves its excess; either expedient may suffice alone; both may be profitably employed in the same case in succession, according to varying circumstances; if the walls of the head are tight and firm, the trocar should precede the bandage; if lax and movable, compression should be cautiously tried, and followed, if need be, by the puncture.[1] Compression should be employed as follows: Cut strips of adhesive or rubber plaster one third of an inch in width; apply first one strip from each mastoid process to the outer part of the orbit on the opposite side; then from the back of the neck along the longitudinal sinus to the root of the nose; next over the whole head so that the strips cross each other at the vertex; finally, pass a long strip three times around the head, just above the ears, eyebrows, and below the occipital protuberance; avoid making the dressing too tight, lest convulsions should be excited; if the health is good and the cap is tolerated it must be continued, but if the increase of fluid threatens convulsions it must be loosened or removed in a few days. If tapping is necessary, proceed as follows: Select a small aspirating needle, or a small trocar, if the aspirator is not used; holding it perpendicularly, insert it at the edge of the anterior fontanelle to avoid the longitudinal sinus and the large veins emptying into it; withdraw the fluid very slowly, meantime maintaining moderate external compression by the hands of an assistant, or a bandage; not more than two or three ounces should be drawn at once, and if the pulse becomes weak, or the dilated pupils contract, or there are signs of convulsions, the needle or canula must be withdrawn, and the puncture hermetically closed. To maintain proper compression, a cap may be in readiness, made of sheet caoutchouc, and perforated with small holes.

5. **Meningocele**[2] (Fig. 233) consists of a protrusion of the meninges of the brain by an accumulation of fluid within the cranium of the new-born infant; the tumor appears at one of the fœtal open-

[1] T. Watson. [2] T. Holmes.

ings of the bones, and is caused by a preëxisting hydrocephalus; the ordinary situation is in the occipital region, and the tumor protrudes through the expanded portion of the occipital bone, behind the foramen magnum, and in the middle line; occasionally this tumor appears at other points, especially at either fontanelle, and at the root of the nose; it has been found at the sides of the skull where the bones are joined, at the inner angle of the orbit, above the orbital arch, in the temporal region, at the base of the skull communicating with the deep parts of the face. The tumor may be a single sac, or have numerous septa; it may be sessile or have a pedicle; it may be translucent like a hydrocele and enlarge when the child cries; or be reducible. The nature of the tumor is recognized by these appearances, and by its being congenital. The dangers of interference with these tumors lies in their relations to the meninges and the brain. In treatment avoid all irritating external applications. As a rule, nothing ought to be done but to support the tumor and make gentle pressure with a bandage, or cap, protected with cotton wool to prevent ulceration, as gutta percha lined with layers of wadding which can be gradually increased in number as the tumor yields to pressure; if it is on the increase without other symptoms, repeated puncture may be tried, the air being excluded; if the tumor has a pedicle, iodine may be injected, using ʒij with equal parts of water, after some of the fluid has been removed. Excision should be practiced when the communication of the tumor with the brain is obliterated; if the operation is undertaken while there is still an opening into the cerebral cavity, the pedicle should be embraced by a clamp, and flaps should be made so as to perfectly cover the wound when united by the continuous suture; the clamp should be retained twenty-four hours or more to preserve proper contact of the opposed surfaces; antiseptic spray should be used during the operation.

Fig. 233.

6. **Encephalocele** resembles meningocele, but its contents consist of a protruding portion of brain, or of brain and dropsical membranes; it appears at the various openings of the skull, and may be sessile or pedunculated; it is recognized as a congenital tumor, often pulsating, generally small and flat; it is most difficult of diagnosis when seated at the root of the nose, in the course of the frontal suture, or near one of the angles of the orbit, as it resembles sebaceous or other tumors; in cases of doubt, the effects of pressure

upon the growth must be carefully noted, and the examination should be several times repeated; it is justifiable to use an exploring needle. The treatment is that of meningocele.

II. THE SPINAL CORD.

1. **Spina bifida** (Fig. 234) is a congenital defect in the bones of the spinal column, which admits the protrusion of the membranes in the form of a hernia; it is of the same nature as a meningocele, and contains subarachnoid fluid, and often nerve trunks, and even the spinal cord itself; hydrocephalus often exists at the same time; the defect may exist at any point in the column, cervical, dorsal, lumbar, or sacral, but the lumbo-sacral form is most frequent; the tumor may have a broad or very narrow base, and directly open into the spinal canal, or be quite disconnected; its coverings may be quite thick, or so thin as to be transparent, or ulcerated so as to allow the escape of its contents; it is usually quite tense when the child is awake and erect. In general this affection proves fatal, sometimes owing to the defective organization of the child, in other cases from convulsions, or an inflammation following an opening of the sac. No case of spina bifida ought ever to be subjected to any active operative interference, except in the most urgent circumstances, and the mildest measure which affords any rational prospect of cure should be the one selected.[1] It may be treated by punctures with needles and compression, the punctures being at the side to avoid nervous tissue; by injections of iodine, as follows: draw off several ounces, then inject five grains iodine, and fifteen grains of iodide of potassium dissolved in an ounce of water; after a few seconds, allow this fluid to flow out, wash the sac with water, and inject two ounces of the original cerebro-spinal fluid;[2] by pressure around the neck of the sac to bring the internal surfaces in contact and secure adhesions and thus shut off the cavity of the tumor from the spinal canal, and admit of its excision; by excision, when there is no nervous tissue in the sac, and the pedicle is small, after applying a clamp several days and thus exciting new action in the sac;[3] or if the base is broad dissecting the soft parts from the sac, opening it by free incision on one side, removing a portion, but reserving a flap to be attached to the root of the pedicle on the other side of the opening into the spinal canal;[1] by evacuation of the contents of the sac, pushing its collapsed parietes back into the canal, and uniting the soft parts over all sufficiently tight to prevent protrusion.[4]

FIG. 234.

[1] T. Holmes. [2] D. Brainard. [3] Wilson. [4] B. Chase.

III. THE NERVES.

1. **Inflammation**,[1] acute, attacks, by preference, the nerves of robust persons and of adults; its seat is the neurilemma and the connective tissue between the bundles of fibres; the changes are due to deranged nutrition, and the nerve varies from a pale rose to a deep red color, and there is a variable increase in the diameter, its component bundles being separated from each other. The symptoms are a tearing, darting, lancinating pain along the course of the nerve trunk with a sensation of tingling, formication, or numbness; it never becomes suddenly severe, nor ceases suddenly, like neuralgia, but is continuous, though variable in severity; is always aggravated by pressure and by the contraction of muscles. The chronic form may result from the acute, or be a continuation of a mild attack, and is a frequent cause of certain kinds of neuralgia, neuroma, and painful subcutaneous tubercle. The treatment of the acute form is the local abstraction of blood, evaporating lotions or anodyne fomentations, and opiates to relieve pain.

2. **Ulceration of nerves**[1] occurs in the neighborhood of ulcers, and causes protracted suffering; the surrounding parts are often enlarged, the skin increases in thickness, the muscles and tendons ulcerate. The treatment is, ointment of well-powdered opium, or opium in water; if remedies fail, excise the nerves as far as possible from the ulcer; it is also advisable to divide the nerve as near the upper part of the wound as possible.

3. **Painful subcutaneous tubercles**[1] are spherical, or oval, or fusiform tumors, generally white, always firm, sometimes hard, having a fibrous or fibro-cartilaginous structure; the size varies from that of a millet seed to that of a pea; they are situated in the subcutaneous areolar tissue, embedded between the fibres of nerves which are separated and stretched over them; they cause the most acute pains, which dart like electric shocks along the course of the nerve. Pain recurs very irregularly, and lasts from ten minutes to two hours or more; it begins gradually, increases in intensity, and gradually decreases, leaving the tubercle and parts around more or less tender; in all cases of obstinate neuralgia of the extremities, search should be made for these tubercles. The only treatment is extirpation.

4. **Neuromata**[1] are larger than subcutaneous tubercles, but may be of every size, from a small grain of wheat to a large melon; they are round, oblong, oval, or fusiform, and when superficial, movable only laterally; they are situated between the neurilemma and nerves, or in the connective tissue between the bundles of nerves; they con-

[1] J. L. Clarke.

sist for the most part of tough and wavy fibrous tissue with a variable number of nuclei and small cells. When they are numerous there is little or no pain, but a solitary neuroma is a source of the most violent agony, which shoots along the nerve like electric shocks. They frequently occur in stumps after amputation, rendering the limb both painful and intolerant of pressure. The only successful treatment is removal, either by excision of the tumor and a portion of the nerve, or by amputation of the limb.

5. **Neuralgia**[1] from nerve injury may depend upon pressure or the presence of foreign bodies, but more often it is a question as to whether the nerve is in a state of inflammation or sclerosis. If the former conditions exist, relief may be easy, as by removing the local cause. If the nerve is inflamed, repeated leeching and the steady application of dry cold for a week or two are the best remedies; if cold cannot be borne hot poultices should be applied. The pains of traumatic neuralgia can only be satisfactorily relieved by narcotic hypodermic injections; the salts of morphia are to be preferred to all others; the fourth of a grain may be given and increased if necessary; if it is desired to maintain the anæsthetic power of morphia without the hypnotic effect, add atropia, thus: to half a grain of sulph. of morphia add one thirtieth of a grain of sulph. of atropia. The alveolar processes sometimes undergo thickening and condensation after the removal of the permanent teeth, which causes such compression of the dental nerves that severe and persistent neuralgia results. The relief from this affection is most readily and effectually secured by removing the diseased process.[2] Make an incision along the ridge of the process; separate the periosteum from the bone by means of the elevator; with rectangular gnawing forceps remove the process to its entire depth; allow the parts to heal by the falling together of the surfaces of the wound. Dissection of nerve from the condensed cicatricial tissue following a gunshot wound has been performed[3] with success, as follows: the median nerve was enclosed in a dense cicatrix at the middle of the arm, involving the biceps muscle, resulting from a gunshot wound; the nerve was gradually laid bare and dissected out, so that it lay perfectly loose in the wound for an inch and a half or two inches of its length; the wound was lightly dressed, and allowed to heal; neuralgia returned slightly, with cicatrization, but eventually disappeared altogether. In extreme cases, amputation of parts is occasionally practiced. Now that it is possible to prevent the reunion of nerves, amputation offers no advantages over resection of the nerve at some higher point; it can, therefore, never be justified, except where more than one nerve is involved, or where the limb has been rendered altogether useless by grave injury.[1]

[1] S. W. Mitchell. [2] J. M. Warren; S. D. Gross. [3] J. M. Warren.

III. THE NERVOUS CONSTITUTION.

Neuromimesis,[1] nervous mimicry, should be duly considered in the diagnosis of surgical affections, for there is scarcely a local organic disease of invisible structures which may not be mimicked by nervous disorder. Examples are frequent in the more or less acute inflammations of the joints, especially of the knee and hip; it imitates diseases of the spine, paraplegia, tetanus, aphonia, deformities, aneurism, and tumors. It may be regarded as a localized manifestation of a certain constitution, but as to what is the peculiarity of the nervous constitution there is no positive knowledge; it may be stated that the nervous centres are too alert, too highly charged with nerve force, two swift in mutual influence, too delicately adjusted or defectively balanced, but these expressions may be misguiding, and it is better to study the nervous constitution in clinical facts. In the great majority of cases there is either history or present evidence of a characteristic nervous constitution; some have been or are truly hysterical, but very many have never been hysterical. The means for diagnosis are to be sought (1) in the general condition of the nervous system on which, as on a predisposing constitution, the nervous mimicry is founded; (2) in the events by which, as by exciting causes, the mimicry may be evoked or localized; (3) in the local symptoms of each case. The treatment is too varied to notice in detail, but must be directed against (1) the local symptoms; (2) the constitutional condition which may co-exist or be combined with the nervous; (3) the nervous constitution itself.

CHAPTER XXVI.

GENERAL OPERATIONS ON THE NERVOUS SYSTEM.

I. THE BRAIN.

Trephining the cranium should be regarded as an operation always fraught with danger,[2] and only to be performed from clear necessity. The following general rules[3] should guide in deciding the question: (1) In diffused injuries to the cranium and its contents all operative interference is unjustifiable; (2) in simple fractures, with or without depression, and in compound fractures that are not comminuted, with or without depression, operative interference is only called for when marked and persistent symptoms of local compression of the brain exist; (3) in compound comminuted fractures, with or without brain symptoms, depressed bone should be elevated

[1] Sir J. Paget. [2] J. Le G. Clarke. [3] T. Bryant.

and fragments removed, with the object of taking away known sources of irritation to the membranes and common causes of encephalitis; (4) in all cases of local injury to the cranium, of fracture or other injury, followed by clear clinical evidence of local inflammation of the bone, and persistent symptoms of brain irritation, or subosteal suppuration, the operation should be undertaken. Proceed as follows: Shave the scalp at the point where the operation is to be performed; place the head upon a firm pillow; give an anæsthetic when the patient is fully conscious; select the point of application of the crown of the trephine so as to avoid the main branches of the middle meningeal artery (Fig. 235), and the longitudinal and other sinuses; make an incision down to the bone, having the form V, +, or other shape, as may be necessary to expose the bone; carefully raise the pericranium over a space just sufficient to admit the trephine; if at any point the elevator can be introduced sufficiently to raise the fragment without using the trephine, elevate the depressed bone very cautiously, until its margin is on a level with the sound bone; if this is impracticable, place the pin upon the margin of the sound bone, and taking the handle in the right hand move it alternately to the right and left, until the teeth have cut a groove sufficiently deep to receive them; the perforator is then loosened and slid up in the shaft and fixed, to avoid wounding the membranes; great care should be taken to maintain the instrument in a position perpendicular to the part operated upon (Fig. 236), in order to avoid its penetrating more deeply on one side than the other, and thus suddenly wounding the cerebral membranes; examine the depth of the groove frequently to ascertain how nearly the instrument has completed the section of the bone. occasionally cleaning the teeth with a small brush or wet sponge; raise the disc of bone with the elevator (Fig. 237). In fractures with depression there are frequently projecting points of bone which it is desirable to remove; this may be done with the bone nippers (Fig. 238). If there is a blood clot, remove

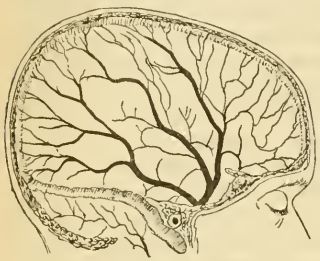


Fig. 235.

Fig. 236.

Fig. 237.

Fig. 238.

it with care, lest bleeding recur; if the meningeal artery is exposed and bleeds, compress it with a piece of sponge, cloth, or wood inserted under the margin of the bone; if the blood or pus producing compression are below the dura mater, open it sufficiently to remove these matters. The conical trephine is to be preferred in all cases where the bone is thin.

II. THE SPINAL CORD.

Trephining the spinal column to relieve compression of the cord, whether from depressed bone or extravasated blood, is now regarded as a useless operation.[1]

III. THE NERVES.

Neurotomy, the section of a nerve; neurectomy, the resection of a portion of a nerve; and stretching of a nerve, are operations undertaken for the relief of pain, and of spasm. These operations are justifiable only as a last resort, all other measures having failed.[2] Section of a nerve should always be made at a point which will involve as few terminal branches as possible, and yet the division must be sufficiently high to include all of the affected trunk, for if diseased tissue is left above the line of division the subacute neuritis and sclerosis may continue to ascend the nerve and render the operation useless; it is important that the area of the painful region should be accurately determined, and the trunk carefully examined for enlargements and hardness by rolling the nerve under the finger; as a rule the section should be a short distance above the point at which the nerve ceases to feel enlarged and hard; if it is practicable to find a spot, even a little farther up the limb, where the nerve is neither swollen nor tender, select that point; when the nerve lies too deep for examination, especially if the neuralgia is of long standing and of traumatic origin, operate as near the body as possible; if the neuralgic cause is purely local, a healthy point is found.[3] But neurotomy, or simple division of a nerve, is at present scarcely ever practiced, owing to the certainty of prompt reunion; resection is necessary and not less than two inches of its length ought to be removed, the object being to make reunion impossible, or very remote in point of time; in addition it is well to turn the peripheral extremity back, and if necessary secure it with a loop of wire, or even interpose muscle or fascia to prevent the possibility of union.[3] Exposure and stretching of spinal nerves as a final resort for the relief of spasms[4] is now recognized as a justifiable operation. It originated in the exposure, isolation, and rubbing of the sciatic nerve[5]

[1] J. Ashurst, Jr. [2] S. W. Mitchell; W. A. Hammond; E. Brown-Sequard.
[3] S. W. Mitchell. [4] Von Nussbaum. [5] T. Billroth.

from a point below the gluteal fold, through the sciatic foramen, to the sacral foramen, for the purpose of relieving epilepsy supposed to be due to some irritating cause affecting the nerve. No such cause was found, but the stretching which the nerve received relieved the spasms. It is believed that the manipulation produces a favorable change in the position of the nerve fibres in the trunk, whereby their nutrition is improved. The procedure is essentially the same as that of dissecting a similarly affected nerve out of cicatricial tissue[1] long since successfully practiced. The operation consists in exposing the nerve and stretching it with fingers, forceps, or blunt hooks, as if attempting to draw it from its connection to the spinal cord.

NERVES OF THE HEAD, FACE, AND NECK.

1. **The supra-orbital nerve** (Fig. 239) is a terminal branch of the frontal, *b*, a portion of the first division of the fifth cranial nerve, *a*; it runs along the roof of the orbit, passes out through the supra-orbital foramen, and ascends upon the forehead. It should be divided as it emerges from the foramen, and before branches are given off. Section is made as follows, 1 (Fig. 239): Recognize the supra-orbital notch, or foramen; pass the tenotome subcutaneously from a point two or three lines on the inner side of the notch outward beyond the notch; turn the blade backwards and cut down to the bone. Resection is made as follows: make an incision an inch in length down to the bone, just above the notch; seize the cut ends of the nerve in the wound and remove it to the desired extent. Or the brow may be raised and the lid depressed, and the incision be made along the edge of the border of the orbit; the nerve is seized in the wound and resected; the wound will fall under the brow when the skin is relaxed.

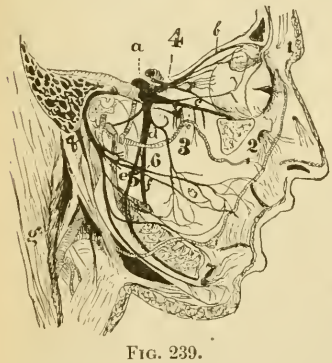


Fig. 239.

2. **The infra-orbital nerves** are the terminal branches of the superior maxillary nerve as it emerges from the infra-orbital foramen, beneath the elevator muscle of the upper lip, and consist of palpebral, nasal, and labial sets.[2] The focus of pain is at the origin of these nerves.[3] Section may be made through the mouth as follows: recognize the infra-orbital foramen, 2 (Fig. 239) above the second bicuspid tooth and nearly half an inch below the margin of the orbit;

[1] J. M. Warren. [2] Quain's Anatomy. [3] Valleix.

raising the upper lip, make an incision along the fold of junction of the lip and maxilla, and continue the dissection to the upper limits of the fossa: now take straight scissors, and continue the dissection upwards to the infra-orbital foramen, which is four or five lines below the orbit in the direction of the first molar tooth; the nerves are readily divided as they emerge from the canal. Section through the skin is made thus: the patient's head being elevated and turned to the other side, recognize the exact position of the foramen by the guides given, and make an incision directly upon it through the skin and fascia.

3. **The superior maxillary nerve**, *c* (Fig 239), is the second branch of the fifth; it passes through the foramen rotundum, across the spheno-maxillary fossa, and traverses the infra-orbital canal in the floor of the orbit and terminates at its foramen. Section is made with a strong tenotome carried along the floor of the orbit in the direction of the nerve; at a depth of two thirds of an inch cut across the floor of the orbit, which is thin, severing the nerve at 3.[1] Resection may at the same time be made by a transverse incision, one third of an inch below the border of the orbit, exposing the nerve, which may be seized and drawn out of the canal.[1] In the more formal operations the external incisions may take various forms, as V, +, U, ⊣, the centre being the foramen: the object is to fully expose the foramen, and the margin of the orbit; the canal may be entered by the trephine applied to the antrum,[2] or by raising the tissues covering the floor of the orbit, and entering the posterior part where the canal is covered by fibrous structures. The trephine is required when the nerve is removed at 4 (Fig. 239), the foramen rotundum;[3] the crown should be small and be so placed as to open the antrum at the canal; the lower wall of the canal is broken with the chisel to the spheno-maxillary fossa; the dissection may now be carried on, and the nerve divided at the foramen rotundum with scissors curved on the flat. The canal may be opened by raising the soft parts from the floor of the orbit an inch or more from the orbital edge, and with a hook set at right angles with its shaft, the nerve may be raised and excised an inch.[4] The latter method is to be preferred when the resection is confined to the portion of nerve in the canal.

4. **The lingual, or gustatory, nerve**, *f* (Fig. 239), one of the special nerves of the taste, supplies the mucous membrane of the mouth, the gums, the sublingual gland, and the papillæ and mucous membrane of the tongue; it is one of the posterior branches of the inferior maxillary branch of the fifth nerve; it is deeply placed, lying first beneath the external pterygoid muscle to the inner side of the inferior

[1] J. F. Malgaigne. [2] J. M. Carnochan. [3] J. R. Wood. [4] T. G. Morton.

dental, then between the internal pterygoid and the inner side of the ramus of the jaw, and crosses to the side of the tongue beneath the stylo-glossus muscle. Resection is made where the nerve lies upon the ramus, 6 (Fig. 239), thus: the mouth opened widely, recognize the pterygo-maxillary ligament below the attachments of which the nerve may be felt on the inner side of the jaw; make an incision backward from the molar tooth over the nerve, an inch in length; the nerve will appear in the wound, and may be picked up and resected; or, draw out the tongue to the opposite side, and make an incision over the sublingual gland, *e* (Fig. 239), continue the dissection through the upper edge of the gland, when the nerve will be exposed and may be excised.[1]

5. **The inferior dental nerve**, *d* (Fig. 239), is a branch of the inferior maxillary: it accompanies the inferior dental artery beneath the external pterygoid between the internal lateral ligament and the ramus of the jaw, to the dental foramen, along the dental canal in the maxillary bone, beneath the teeth, to the mental foramen. Resection may be intrabuccal, or by external incision. The intrabuccal operation is as follows:[2] the corner of the mouth being held wide open, make an incision about one inch long, obliquely from within outwards, along the anterior border of the ramus of the jaw through the anterior fibres of the internal pterygoid muscle; tear through the connective tissue between the pterygoid and the periosteum with the finger, when the nerve is easily reached at its entrance into the dental canal. Resection by external incision may be made at any point of the course of the nerve. If the trunk is to be removed before the nerve enters the canal, 5 (Fig. 239), make an incision from the sigmoid notch down to the edge of the jaw, raise and turn back the parotid gland, dissect up the lower portion of the masseter muscle, and remove a section of bone with the trephine; half an inch of the nerve is exposed for resection; the dental artery is liable to be cut, but may be ligated.[3] Resection of any portion of the nerve in the canal may be effected by raising a flap, exposing the bone, and applying the trephine once, twice, or more, and removing the external wall of the canal.[4] Or, the trephine may be applied at two different points, the nerve trunk cut in them, and that portion then be extracted.[5] The terminal portion of the inferior dental, as it emerges from the mental foramen, 7 (Fig. 239), is distributed to the integument of the chin and lower lip. Resection is made at the foramen thus: Evert the lower lip, and make an incision down to the bone where the lip and gum unite along the groove which separates the alveoli of the canine and first molar teeth; the ends of the divided nerve appear in the wound; seize the proximal end with forceps and draw out of the canal as much as possible.

[1] J. Hilton. [2] Paravicini. [3] J. M. Warren. [4] S. D. Gross. [5] C. Sédillot.

6. **The facial nerve,** 8 (Fig. 239) emerges from the cranium at the stylo mastoid foramen, and passing through the parotid gland divides into the temporo-facial and cervico-facial branches. Section of the nerve trunk may be made at the stylo-mastoid foramen as follows: Make an incision vertically two inches in length along the anterior border of the process, and of the sterno-mastoid muscle; draw the parotid gland strongly forwards and dissect with the handle of the scalpel to a depth varying from a half to three fourths of an inch, when the nerve will be found crossing the wound; the internal jugular vein is within a quarter of an inch of the foramen, and in the direction of the wound. The temporal branch may be divided where it crosses the condyle, by an incision slightly oblique from before backwards, starting from the zygomatic arch and terminating above the posterior border of the angle of the jaw; the dissection should be continued through the connective tissue, the parotid gland being drawn down when exposed; the nerve will be found close to the bone and separated from it by connective tissue.

NERVES OF THE UPPER LIMB.

The nerves of the upper limb requiring section are branches of the brachial plexus, which is composed of the four lower cervical and first dorsal nerves.

1. **The brachial plexus** may require resection when the neuralgic condition involves a large number of branches. The part most favorably situated for resection is the first combination of nerves in the two cords. These nerves lie above and to the outer side of the subclavian artery, and external to the scalenus anticus muscle. Operate as follows:[1] Elevate the shoulders, drop the head backwards with the face strongly inclined to the sound side; this renders the tissues of the affected side tense, and makes prominent the sterno-cleido-mastoid, the landmark for the first incision; an assistant makes the external jugular prominent by compressing it with a finger applied over the upper margin of the clavicle at its middle, or on a line drawn from the angle of the jaw to the middle

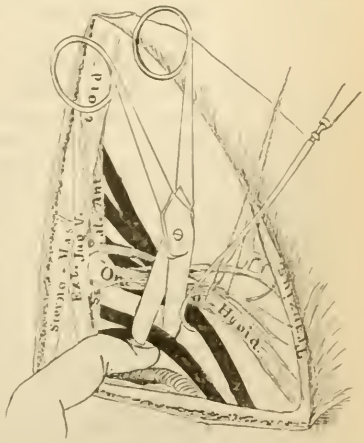


Fig. 240.

[1] H. B. Sands; F. F. Maury.

of the clavicle; make an incision downwards along the external border of the sterno cleido-mastoid beginning three inches above the clavicle; from this point make a second incision along the course of the clavicle, giving an L form to the incisions of the integument; the length of both incisions must be regulated by the size of the neck of the patient; the next important guide is the tendon of the omo-hyoid muscle, which must be searched for with the finger and handle of the scalpel, the external jugular vein being drawn aside; the posterior belly of the omo-hyoid being recognized is held aside by the finger or ligature; the two cords of the plexus now appear; place a ligature loosely around the upper cord by means of the aneurism needle, or hold it aside with a blunt hook (Fig. 240); pass the index finger of the left hand into the wound and ascertain the exact position of the subclavian artery, which is to be held out of the way and carefully protected; now divide the cord as near the finger of the left hand as possible, with blunt pointed scissors, and make a second division above the point of section, as far up as practicable, care being taken not to interfere with the scalenus anticus muscle across which passes the phrenic nerve; four fifths of an inch of the cord may be removed, and the cut ends by retraction separated two and a quarter inches. The outer cord is next resected to the requisite extent. The outer cord may be cut first, and then the inner, by carefully protecting the subclavian artery, as it lies in immediate proximity with the latter cord.

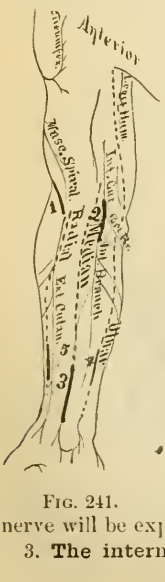


Fig. 241.

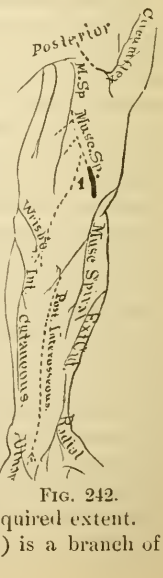


Fig. 242.

2. **The external, or musculo-cutaneous nerve,** 1 (Fig. 241) rises from the outer cord of the brachial plexus, passes obliquely between the biceps and brachialis anticus to the outer side of arm, then becomes cutaneous, and is distributed to the integument of the radial border of the arm. Recognizing the space above the elbow, between the biceps and the anterior border of the supinator radii longus, make an incision two inches in length, oblique from above downwards, and from behind forwards; divide the skin, fascia, and aponeurosis, and the nerve will be exposed, and may be resected to the required extent.

3. **The internal cutaneous nerve,** 2 (Fig. 241) is a branch of

the internal cord, and is distributed to the internal portions of the forearm. Make an incision obliquely from the lower part of the biceps downward and inward to a point an inch below the internal condyle; cut only through the skin, then open the connective tissue, in which the nerve will be found.

4. **The musculo-spiral nerve**, 1 (Fig. 242), is the largest branch of the brachial plexus, and is distributed to the muscles and skin of the posterior surface of the arm, forearm, and hand; it winds around the arm in a groove, with the superior profunda artery, passing from the inner to the outer side of the bone, beneath the triceps muscle; it descends between the brachialis anticus and supinator longus to the front of the external condyle, where it divides into the radial and posterior interosseous.[1] Resection is made above the external condyle as follows: Make an incision three inches in length along the external border of the triceps muscle, and between it and the brachialis anticus. Commencing three inches above the external condyle, and in line with it, dissect the connective tissue with the handle of the scalpel; the nerve is readily exposed close to the bone, and may be resected to any necessary extent. Or the nerve may be exposed above and internal to the external condyle, by recognizing the space between the supinator longus and the brachialis anticus, and making an incision two and a half inches long.

5 **The median nerve**, 3 (Fig. 241), has been excised for neuralgia in the lower part of the forearm below the origins of the muscular and anterior interosseous branches, and above the origin of the palmar cutaneous branch.[2] Ascertain precisely the margins of the flexor carpi radialis and palmaris longus muscles by extending the hand upon the forearm; make an oblique incision two and a half inches long from over the border of the first to that of the last-named muscle, the lower end of the incision terminating two inches above the line of the wrist joint; divide the superficial fascia and muscular aponeurosis on a director; seek the nerve in the intermuscular space, and expose it at the lower end of the cut, where it emerges from beneath the oblique fleshy fibres of the flexor sublimis digitorum; raise this muscle and the nerve will be exposed the length of the cut.

6. **The radial and ulnar nerves** may be resected by the same operative procedures as are taken in ligature of the respective arteries which they accompany, 4, 5 (Fig. 241).

7. **The digital nerves**[3] may be excised by an incision on the inner or outer aspect of the first phalanx of the finger; in severe cases of neuralgia, resection should be performed on both sides of the finger; subcutaneous section of these nerves may be made by passing a narrow-bladed knife on both sides.

[1] H. Gray. [2] J. H. Brinton. [3] J. M. Warren.

NERVES OF THE LOWER LIMB.

The nerves of the lower limb requiring section are branches of the lumbar and sacral plexus.

1. **The great sciatic**, 5 (Fig. 243), the largest nerve of the sacral plexus, supplies largely the integument of the leg. Place the patient on the abdomen; recognize the gluteal fold, and the point of junction of the flexor muscles of the thigh, make an incision three inches long through the skin, fascia, and connective tissue; with the finger and handle of the scalpel expose the nerve, and resect to the required extent.[1]

Fig. 243.

2. **The popliteal nerve**, 3 (Fig. 243), the continuation of the great sciatic, may be resected at the interval between the flexor muscles above the popliteal space; the incision being made through the skin and fascia, the nerve should be uncovered by dissection with the finger and handle of the scalpel, and an inch and a half removed.

3. **The perineal nerve** is the larger branch of the pudic; it is distributed to the organs of generation. It has been divided for severe vaginal neuralgia successfully,[2] as follows: With the finger introduced deeply into the vagina, recognize the nerve, which feels as a hard cord and is very sensitive on pressure; make a deep vertical incision, which will bring the nerve into view; remove it to the extent of an inch.

4. **The small sciatic nerve**, 4 (Fig. 243), has been excised[3] for multiple neuroma successfully, as nearly as possible to its origin, by an oblique incision almost in the direction of the gluteal fold; the portion of nerve was removed from under the edge of the gluteus maximus.

5. **The peroneal or external popliteal nerve** is, 2 (Fig. 243) given off from the popliteal nerve and passes along the inner margin of the tendon of the biceps, or external hamstring muscle. It is excised as follows: Make an incision two to three inches long, on the inner border of the biceps tendon, through the integument and superficial fascia; the nerve will be found close to the tendon and may be easily excised to the extent of an inch or more.

6. **The anterior and posterior tibial nerves**, 2 (Fig. 244), 6 (Fig. 243) accompany their respective arteries in such proximity that the incisions for the ligature of these arteries may be adopted for the resection of the nerves.

[1] T. Billroth. [2] T. G. Morton. [3] Kosinski.

7. **The internal saphenous nerve,** 1 (Fig. 241), is a branch of the anterior crural and is distributed to the integument on the inner side of the leg; it lies superficially in immediate relations with the internal saphenous vein. Make an incision along the track of the vein made prominent by pressure above; the nerve lies immediately behind the vein; if necessary, the vein may also be divided and tied. It (3. Fig. 244) may also be resected where it emerges from beneath the sartorius muscle at the inside of the knee. Recognize the sartorius and gracilis muscles at the inside of the knee, and the trunk of the internal saphenous vein by compressing it above; make an incision two inches long in the course of the vein through the skin and fascia, draw the vein aside, and the nerve will be found as it escapes from the deep aponeurosis and may be resected to the desired extent.

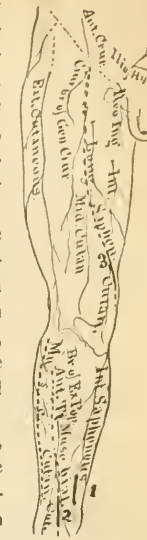


Fig. 244.

8. **The external saphenous nerve,** 1 (Fig. 243), a branch of the lumbar plexus, descends along the fibular side of the posterior surface of the leg in connection with the vein of the same name. Make an incision along the vein, distended by pressure above, behind the malleolus, or external to the tendo-Achillis; carefully turn the vein aside and the nerve will be exposed.

9. **The internal plantar nerve** has been successfully resected[1] for tetanus caused by injury of the digital branches. The nerve is the larger division of the posterior tibial and accompanies the internal plantar artery; from the point of division of the posterior tibial nerve between the internal malleolus and heel, it is directed forwards under cover of the abductor of the great toe, passing between that muscle and the short flexor of the toes. Make an incision along the internal margin of the foot, commencing at the anterior border of the heel about one fourth of the distance from the inner to the outer margin, forwards two inches; this incision will be along the external margin of the abductor pollicis; carefully open the space between this abductor and the short flexor and the artery will be recognized with the nerve accompanying it, which may be resected an inch or more.

[1] G. E. Foster.

VI.

THE TEGUMENTARY SYSTEM.

THE SKIN; THE HAIR AND GLANDS; THE NAILS.

CHAPTER XXVII.

INJURIES OF THE TEGUMENTARY SYSTEM AND SPECIAL OPERATIONS.

I. THE SKIN.

Though the skin consists of several separate tissues, as the epiderms and papillary body, the corium and subcutaneous areolar tissue, and glands,[1] they are all so implicated in injuries, and the various results which follow, that they cannot practically be isolated.

1. **Contusion**[2] without external wound is the common bruise of skin and subcutaneous tissue, and may be of various degrees of severity; when slight, the textures suffer only shaking or jarring, followed by rupture of blood vessels and effusion of fluid; in severe contusions the damaged structures are broken, and there may be visible ruptures of soft parts, especially splittings of the subcutaneous tissue, and separations of it from the fasciæ; in extreme cases the parts are thoroughly crushed. Swelling generally quickly follows the violence; first, there is some depression or indentation, with softening of the injured tissues; swelling succeeds, due partly to extravasation, but much more to the rapid afflux of blood and exudation from the vessels. The most frequent subcutaneous hæmorrhages are from the veins; if the extravasation is into the cutis it has a dark blue color, passing into brown; if it escape more deeply and slowly, the blood forms a passage-way between the connective tissue and muscles, infiltrating the tissues and causing swelling, suggillation; if much blood escape suddenly and create a distinct cavity, it forms a blood-tumor, ecchymosis, or hæmatoma.

[1] E. Rindfleisch.

[2] Sir J. Paget.

The colors of ordinary recent contusions are various shades of purple tending either to black or blue, or to crimson, or pink; and with these are mingled shades of yellow, pale brown, and green, dependent, apparently, on the quantity of effused serum and its mingling with fluids of other colors; after a variable time the darker colors fade out, and give place to gradually lightening shades of brownish olive, green, and yellow, the changes commencing at the border.

In the treatment, when the effusion is going on, ice may be applied, the limb or part being suitably elevated. Simple contusions, left to themselves in the quietude necessary to avoid pain, recover, but the process may be hastened by stimulant applications, the best of which, except for persons of irritable skins, seems to be tr. arnica, with equal parts of water; if there is much breaking and crushing of tissues the parts should be kept warm to prevent sloughing, with wrappings of cotton-wool soaked in oil, or linseed poultices; extreme cases should be treated as for traumatic gangrene; if the blood remain in large quantities, friction and kneading may promote absorption by diffusing it in the tissues; if it still remain, evacuate it with antiseptic precautions, and treat the cavity as an open abscess.

2. **Incised wounds** [1] are made with sharp instruments, as knives, sabres; the edges are smooth-cut, regular, the tissue unchanged. Pain follows the injury at once, varying with the nerve supply of the part and the sensitiveness of the patient; the feeling is that of a peculiar burning or smarting; hæmorrhage is the second immediate symptom, its extent depending upon the number, size, and variety of the vessels divided: if the capillaries alone bleed, the hæmorrhage quickly ceases; if an artery is cut, the bright red blood flows in a stream, often pulsatile; hæmorrhage from the veins is characterized by the steady flow of dark blood.

A rapid, excessive loss of blood induces perceptible changes in the whole body; the face, especially the lips, becomes pale — the latter bluish, the pulse is smaller, and at first less frequent; the bodily temperature sinks, and most perceptibly in the extremities; the patient faints on rising, has dizziness, nausea, or vomiting, noises in the ear, and everything whirls around: he becomes unconscious, and falls, owing to rapid anæmia of the brain. In the horizontal posture, these effects usually soon pass off; but if the bleeding continue the countenance grows paler and waxy, the lips pale blue, the eyes dull, the bodily temperature lower; the pulse is small, thready, and very frequent; respiration is incomplete: the patient faints repeatedly, constantly grows more feeble and anxious; at last he becomes unconscious; there is twitching of the arms and legs, renewed by the slightest irritation; this state may pass into death.

The treatment of an incised wound demands, first, the arrest of hæmorrhage; second, perfect quiet of the injured part, in a position to diminish the flow of blood to and through the part. If the bleeding is capillary, it will usually cease on exposure of the wound to the

[1] T. Billroth.

air, or the application of cold, as ice water, or, for more permanent effect, in ice-bags; other simple remedies are alum solution, vinegar, dry lint; more powerful hæmostatics are liq. ferri persulphate, turpentine, creosote, hot iron.

In the use of these remedies it should be remembered that in proportion as an incised wound is disturbed, and its sensitive surfaces exposed to irritation, the possibility of prompt union is diminished; as a rule, therefore, where compression or ligation will answer, avoid styptics, and resort to them only when it makes no difference whether the wound suppurates or not.

Compression may be required for immediate or permanent effect. For immediate compression, use the fingers, thumb, or a key, according to the situation and depth of the artery.

The arteries more often requiring compression, and the points at which pressure is to be made, are, the carotid against the vertebræ, with the fingers of the right hand applied along the anterior border of the sterno-mastoid muscle, about the middle of the neck; the subclavian against the first rib, with the right thumb behind the outer border of the relaxed sterno-cleido-mastoid muscle; the brachial against the humerus, with the fingers placed along the inner side of the belly of the biceps about the middle of the arm; the femoral against the pubic bone just below Poupart's ligament, with the thumb.

For more permanent compression use the tourniquet, where it can be applied without harm, as to the femoral.

The best form of tourniquet for this purpose compresses the limb at but two points (Fig. 168), namely, over the artery, and at an opposite point; this tourniquet can be used for compression of the femoral or abdominal artery.

Compression as a permanent hæmostatic, as in venous hæmorrhage, bleeding from numerous small vessels, and especially when parenchymatous, must be made with the nicely adjusted compresses, and bandages, applied from the toes or fingers above the wound. Ligation is practiced when the bleeding vessel is an artery; in an ordinary wound the ligature should be carbolized catgut, which admits of the immediate and complete closure of the wound; silk is best if the wound is to heal by granulation. If the artery has retracted and cannot be isolated, take up with the forceps, or with a curved, threaded neeedle, the connective tissue into which the artery has withdrawn, and inclose the whole in the ligature. Cut the ends of the catgut ligature close, but let one end of the silk ligature depend from the wound. Torsion may be practiced when the arteries are small. Seal hermetically with collodion, if there is no gaping of edges. Employ common adhesive plaster, or, better, adhesive rubber plaster, if gaping is slight; add sutures, if it gape

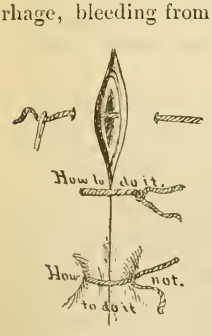


FIG. 245.

widely, tie with the surgeon's knot, but do not draw them so firmly as to cause strangulation of the integument (Fig. 245);[1] apply such additional dressing as will secure perfect rest; change the dressing only for cleanliness; remove sutures when they irritate, or no longer support the wound.

3. **Contused and lacerated wounds**[2] may be simple solutions of continuity, or be attended with loss of substance. The borders are generally uneven tags, and not unfrequently large flaps of the soft parts hang in the wound, having a bluish-red color; the skin for some distance is often detached from the fascia, especially if the contusing force was combined with tearing and twisting; tendons are torn or pulled out; the skin-wound usually gives no means of judging of the extent and depth of the contusion. The pain is not great, especially if parts have been crushed; the bleeding is slight, and not in a stream; even if large arteries and veins are involved, the blood will ooze from the wound.

This is due to the plugging of the arteries by the in-rolling of their coats, and feeble action of the heart from shock.

When reaction occurs, hæmorrhage may take place from vessels which have not previously bled, and now require the ligature. The treatment depends upon the extent of injury; if slight, the parts may be trimmed with the knife, and the edges be converted into an incised wound. The severe forms must heal by secondary union, and only after the dead tissues have been separated by granulation. The first applications to an ordinary contused and lacerated wound should be cold, to diminish the tendency to excessive suppuration. This is best effected by immersion in cold carbolized water, kept cool by ice; if immersion is impracticable, the part may be surrounded by ice-bladders, or ice-compresses; irrigation with cold water may be employed, but is less reliable, the temperature of the water varying from 54° to 90° F., as the patient may prefer. This treatment should be continued eight to twelve days, when the part may be removed from the water and dressed with cloths wet with carbolized water, covered with oiled silk. In many cases, the hot water treatment may well be substituted at an early period, or adopted from the first to hasten the separating process.

The water bath does not favor the escape of pus, but rather prevents it; and hence where there is suppuration from a cavity the water bath is of no use, but is even injurious; it should be discontinued when deep, progressive inflammation extends beyond the wound. It must be remembered that the water bath greatly retards the healing process, and hence the necessity for discontinuing it as early as practicable, and substituting simple dressings.

4. **Gunshot wounds**[3] vary in extent and severity according to

[1] T. Bryant. [2] T. Billroth. [3] T. Longmore.

the nature of the missiles and the conditions under which they expend their force. When a cannon-ball at full speed strikes in direct line a part of the body it carries away all before it; in case the force of the cannon-shot is partly expended, the extremity or portion of the trunk may be equally carried away, but the laceration of the remaining parts of the body will be greater, and the surface of the wound will be less even; if the speed be diminished so that the projectile becomes spent, there will not be removal of the part of the body struck, but the external appearance will be limited usually to ecchymosis and tumefaction, without division of surface, or even these may be wanting, notwithstanding the existence of serious internal disorganization; should a cannon-ball strike in a slanting direction, the external appearance of the wound will be similar to those just described, according to its velocity, modified only in extent by the degree of obliquity with which the shot is carried into contact with the trunk or extremity wounded; large fragments of heavy shells generally produce immense laceration and separation of the parts against which they strike, but do not carry away or grind, as round shot; small projectiles, with force enough to penetrate the body, leave one or more openings, the external appearances of which also vary according to their form and velocity; when the musket-ball strikes at a distance from the weapon by which it was propelled, but still preserves great velocity, an opening is observed, irregularly circular, with edges generally a little torn, the whole wound is slightly inverted, and there may be darkening of the margin, of a livid purple tinge, from the effects of contusion, or it may be simply dead-like and pale; should the ball have passed out, the wound of exit will be probably larger, more torn, with slight eversion of its edges, and protrusion of the subcutaneous fat, which is thus rendered visible; these appearances are the more easily recognized the earlier the wound is examined, and are more obvious if a round musket-ball has caused the injury than when it has been inflicted by a cylindro-conoidal bullet.

A musket-ball ordinarily causes either one wound, as when after entering it lodges, or, as sometimes happens, from its escaping again by the wound of entrance; or two wounds, from making its exit at some point remote from the spot where it entered; but occasionally leads to a greater number of openings; this last result may happen from the ball splitting into two or more portions within the body, and causing so many wounds of exit; the number of wounds made by one ball may be increased by its traversing two adjoining extremities of the same person, or even distant parts of the body, from accidental relative position at the time of the injury. The two openings made by one ball may hold such a relative situation as to lead to the mistake of their being supposed to be caused by two distinct balls. Length of traverse, and consequent distance between the two openings, parts of the body brought into unusual relations from peculiarities of posture, and peculiar deflections of the ball, may all be

sources of this error. The appearances of wounds resulting from penetrating missiles of irregular forms, as small pieces of shells, musket-balls flattened against stones, and others, differ from those caused by ordinary bullets in being accompanied with more laceration, according to their length and form; being usually projected with considerably less force than direct missiles, such projectiles ordinarily lead to only one aperture, that of entrance.

A wound by musket-shot is attended with an amount of pain which varies very much in degree according to the kind of wound, and condition of mind, and state of constitution; sometimes it is described as a sudden, smart stroke of a cane; in other instances as the shock of a heavy, intense blow; occasionally the pain will be referred to a part not involved in the track of the wound; when a ball does not penetrate, but simply inflicts a contusion, the pain is described as more severe than where an opening has been made by it. As a general rule, the graver the injury, the greater and more persistent is the amount of shock.

In the examination of these wounds it is important to place the patient, as nearly as can be ascertained, in a position similar to that in which he was, in relation to the missile, at the time of being struck.

When only one opening has been made by a ball, it is to be presumed that it is lodged somewhere in the wound, and search must be made for it accordingly. But even where two openings exist, and evidence is afforded that these are the apertures of entrance and exit of one projectile, examination should still be made to detect the presence of foreign bodies. Portions of clothing, and other harder substances, are not unfrequently carried into a wound by a ball; and, though it itself may pass out, these may remain behind, either from being diverted from the straight line of the wound, or from being caught and impacted in the fibrous tissue through which the ball has passed. The inspection of the garments worn over the part wounded may often serve as a guide in determining whether foreign bodies have entered or not, and, if so, their kind.

Of all instruments for conducting an examination of a gunshot wound, the finger is the most appropriate. By its means the direction of the wound can be ascertained with least disturbance of the several structures through which it takes its course. The index finger naturally occurs as the most convenient for this employment; but the opening through the skin is sometimes too contracted to admit its entrance, and in this case the substitution of the little finger will usually answer all the purposes intended. When the finger fails to reach sufficiently far, owing to the depth of the wound, the examination is often facilitated by pressing the soft parts from an opposite direction towards the finger-end. Where the finger is not sufficiently long to reach the bottom of the wound, even when the soft parts have been approximated by pressure from an opposite direction, and when the lodgment of a projectile is suspected, a probe is the best substitute. It may be single, *n* (Fig. 246), or jointed,

l, *m*, *n*. It must be employed with great nicety and care, for it may inflict injury on vessels or other structures which have escaped from direct contact with the ball, but have returned, by their elasticity, to the situations from which they had been pushed or drawn aside during its passage. But frequently it is difficult to determine whether any solid body felt with the probe is lead, and for this purpose the end of the probe may be of porcelain, which is marked only by lead,[1] *a* (Fig. 247), or which has a burr, *h*, *j* (Fig. 246), which will chip off fragments of lead when rotated on the ball. An electrical probe has been devised[2] which is very delicate in its action.

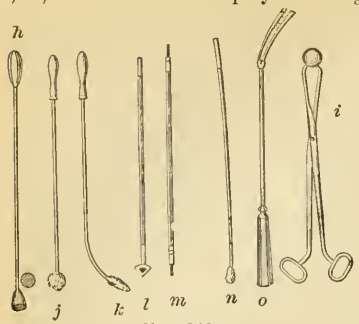


Fig. 246.

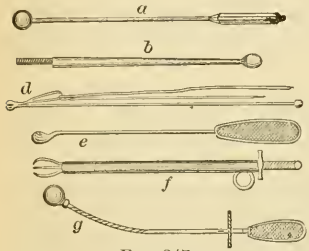


Fig. 247.

It consists of two pointed steel wires, projecting about four inches from an ivory handle (Fig. 248); they are surrounded near their points by a tube of vulcanite inclosed in a slotted tube of German silver, and may be moved slightly forward so as to project beyond this by means of a button to which they are connected, sliding in the slot; the other ends of the wire are connected with the terminals of a galvanic battery, forming an open circuit; the battery is formed of a zinc and carbon element, inclosed in a case of hardened India-rubber hermetically sealed, the exciting liquid being bisulphide of mercury; for use, the probe is pushed into the wound until a resistance is encountered which in the judgment of the operator may be the bullet. The points are then protruded and the instrument turned about, if necessary, until both points touch the object, when, if it be the bullet sought, the circuit is completed by metallic contact, actuating the armature of an electro-magnet and causing it to ring a bell. A small pocket instrument has also been invented.[3]

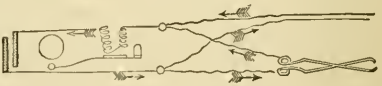


Fig. 248.

As soon as the presence of a ball or other foreign body is ascertained it should be removed; if it be lying within reach from the the wound of entrance it should be extracted through this opening by means of some of the various instruments devised for the purpose (*i*, Fig. 246, *e*, *f*, Fig. 247).

[1] E. Nélaton. [2] M. Trouvé. [3] T. Longmore.

The way to the removal of a bullet may often be smoothed by judiciously clearing away the fibres, among which it is lodged, during the examination by the finger; and sometimes, by means of the finger in the wound, and external pressure of the surrounding parts, the projectile may be brought near to the aperture of entrance, so that its extraction is still further facilitated. Such foreign substances as pieces of cloth can usually be brought out by the finger alone, or by pressing them between the finger and a silver probe inserted for the purpose. Sometimes a long pair of dressing-forceps, guided by the finger, is found necessary for effecting this object. Caution must be used in employing forceps, where the foreign substance is out of sight and of such a quality that the soft tissues may be mistaken for it. It does not often happen that it is necessary to enlarge the openings of wounds to remove balls, although a certain amount of constriction of the skin may be expected from the addition of the instrument employed in the extraction; but if much resistance is offered to their passage out, it is better to divide the edges of the fascia and skin to the amount of enlargement required than to use force. In removing fragments of shells or detached pieces of bone, the fascia and skin have almost invariably to be divided to a considerable extent.

In instances where the foreign body has not completely penetrated, but is found lying beneath the skin away from the wound of entrance, an incision must be made for its extraction; before using the knife, the substance to be removed should be fixed *in situ*, by pressure on the surrounding parts; in the instance of a round ball, the incision should be carried beyond the length of its diameter; an addition of half a diameter is usually sufficient to admit of the easy extraction of the ball. In removing conical balls, slugs, fragments of shells, stones, and other irregularly-shaped bodies, the surgeon cannot be too guarded in arranging so that the fragment will present its long axis in line with the track of the wound. To effect this object, it is necessary to seize the missile in such manner as to bring its long axis to correspond with that of the track of the wound. (Fig. 249.)

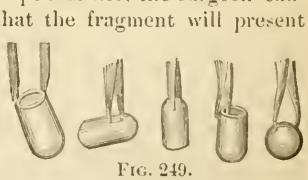


Fig. 249.

When there is reason for concluding that a ball or other foreign body has lodged, but after manual examination, and observation as well by varied posture of the part of the body supposed to be implicated as by indications derived from the patient's sensations, effects of pressure, or injury to nerves, and all other circumstances which may lead to information, the site of lodgment cannot be ascertained, the search should not be persevered in to the distress of the patient. Neither, although the site of lodgment be ascertained, if extensive incisions are required, or if there is danger of wounding important organs, should the attempts at extraction be continued. Either during the process of suppuration, by some accidental muscular contraction, or by gradual approach towards the surface, its escape may be eventually effected; or, if of a favorable form, and if not in contact with nerve, bone, or other important organ, it may become encysted, and remain without causing pain or mischief.

All foreign matters being removed, the wound must be syringed with carbolic solution to its deepest recesses, suitable drainage provided, and a position of perfect rest secured. It may be closed with adhesive strip, and ice-bladders applied, but carbolized spray and solutions should be used at each change of the dressings, if possible. When much local inflammation has set in, and when there is much constitutional fever, even without unusual local irritation, the non-evaporating or warm applications will be found to be the most advantageous. When suppurative action has been fully established, care must be taken to prevent the accumulation of pus, lest it burrow, and sinuses become established, not an unfrequent result of want of sufficient caution in this regard; if much tumefaction of muscular tissues beneath fasciæ occurs, or abscesses form in them, free incisions should be at once made for their relief.

5. **Poisoned wounds** are wounds inoculated with a poison capable of producing either (1) fever and its complications; or (2) symptoms of specific general poisoning; or (3) definite diseases.[1] (1.) The first variety of poison is developed in decomposition of animal matters, and appears in butchers, cooks, and those engaged in dissections.

Ordinary dissection wounds are generally harmless, unless the person is very susceptible; it is in the bodies of those dead of pyæmial diseases, as puerperal peritonitis, that the poison is especially virulent; in these cases it may enter the system even through the unbroken skin.[2]

The effects of the poison may appear in various degrees of severity; (*a*) there may be a slight induration of the part, with moderate pain, followed by a dry scale which recurs as often as it is removed; the epidermis thickens over it and forms a painful, wart-like nodule — the anatomical tubercle;[3] (*b*) there may be an inflammation of the lymphatic vessels and axillary glands terminating in abscesses; (*c*) the poison may develop an acute septicæmia and rapidly prove fatal;[4] (*d*) the course of the poison may be chronic, involving the glands, and inducing wide-spreading, phlegmonous inflammations and abscess.[2] The treatment at the outset should be irrigations of the wound with cold water, or sucking it with the mouth; immediate cauterization is unadvisable;[5] if lymphangitis appear, place the limb in quiet position and apply a lotion of opium and lead; if abscesses form, evacuate them early, disinfect the interior with carbolic solutions, give opium to alleviate pain, and wine and nourishing food for the general strength; if the disease run an acute course, this treatment must be much more energetically enforced. (2.) The second variety of poison emanates from venomous animals, as wasps, hornets, bees,

[1] T. Holmes. [2] Sir J. Paget. [3] S. Wilkes. [4] T. Billroth.
[5] Sir J. Paget; T. Billroth.

snakes, scorpions. The effects of the sting of wasps and bees rarely extend beyond the immediate vicinity of the injury, and require, at the most, only the application of vinegar, or ammonia in solution, and simple domestic remedies, as bread-and-water poultice. The same treatment may be pursued in the bites of snakes, unless they are known to be dangerously poisonous, as that of the rattlesnake; in such a case prompt action is required, namely, a ligature should be tied so firmly around the part as to interrupt all circulation; if it is a finger, amputate at once; otherwise excise the wound thoroughly, and suck the blood from the part; finally, cauterize the surface. The subsequent treatment will depend upon the symptoms as they develop. (3.) The third [1] form of poison causes specific diseases, and is derived from the secretions of animals affected with glanders and hydrophobia. Glanders in man results from inoculation of a wound with the pus from the nares of the affected horse; it excites severe and widespread inflammation, with all the symptoms of acute septicæmia. The treatment must be directed by the symptoms. Hydrophobia results from the inoculation of a wound by the saliva of a rabid animal, as a dog or cat; the bite usually heals readily, but it is more favorable if the wound suppurates freely; the disease rarely appears under six weeks, and frequently later. The treatment should be cauterization of the wound, and promotion of suppuration; after the appearance of symptoms there is no hope. Excision of the cicatrix may be resorted to, though amputation even has proved useless.

6. **Frost-bite,**[1] or chilling of parts by cold, occurs more often when cold is accompanied with moisture; closely-fitting clothes, which impede circulation, increase the predisposition. It may be so slight as to cause simple numbness of the fingers or toes, and whiteness of the skin; when these symptoms subside the skin becomes red, the fingers swell, and there is a peculiar itching and prickling; no other treatment is required than rubbing the parts and restoring the circulation by degrees; the redness may remain long after recovery, and even become permanent. A severe form appears in the rising of vesicles with complete loss of sensation; there is now danger of mortification; the treatment consists in a very gradual change to a higher temperature, snow or ice may be rubbed upon the parts, or cloths dipped in ice-water applied. Or, there may be the formation of eschars; the parts are then quite destroyed by the cold, and sloughs form as in severe burns; the treatment is the same as in the milder cases, but the ulcers which result from the slough require a long period in which to cicatrize.

7. **Chilblains**, pernioes, result from repeated freezings, causing

[1] T. Billroth.

paralysis of the capillaries with serous exudations in the cutis.[1] There may be simple congestion attended with itching, alternating with extreme tenderness; or there may be vesication, and, in extreme cases, death of the skin or areolar tissue; usually there is a daily attack of congestion occurring in the afternoon or evening, with increased heat and swelling, followed by itching, then swelling, and finally, soreness, aching, and extreme sensibility.[2] In treatment, direct loosely fitting and warm coverings for the parts, and applications which relieve the local distress; the latter must be selected by the experience of each patient. Those generally useful, where the skin is unbroken, are stimulating liniments, as, camphorated oil; equal parts turpentine and copaiba; tr. iodine; tr. cantharides 1 part, and soap liniment, 3 parts; solutions of nitrate of silver; to relieve itching, cold water, or hot mustard water are most effective; if there are vesicles, collodion is very serviceable; for ulcers, bals. Peru is necessary.

8. **Burns and scalds** may be of different degrees of severity, but the risk to life is to be measured by the extent of surface involved; they are most serious to the young and the old, but at all ages extensive burns are to be feared; first, from their immediate depressing effects; second, from inflammatory complications; and, third, from suppuration; when the injury is over the thoracic region, chest complications are liable to follow; if over the abdomen, dangerous intestinal affections may appear.[3] The several grades of burns are as follows: (1.) They may be so slight as to cause simple redness of the skin, due to a dilatation of the capillaries, and slight exudation of serum in the tissue of the cutis; there is a mild grade of inflammation, followed in many cases with detachment of the epidermis; the pain is severe for a few hours. The treatment depends upon the extent of surface involved. If it is limited, apply soothing remedies, as, cold water, lead water, scraped potatoes, or such one of the domestic articles recommended as may be convenient.[4] (2.) The burn may be deeper, followed by the formation of vesicles, due to the rapid escape of fluid from the capillaries between the mucous and horny layer.[1] If this burn is quite limited, recovery is rapid and satisfactory; but if spread over a large surface, the shock and collapse may be severe, and recovery uncertain. The treatment should be directed first to the shock and depression, which may be mitigated by external warmth with hot drinks, stimulants, and opium to relieve pain; next, remove the clothes, with care to avoid tearing off the vesicles, and puncture the blisters at the most depending part to allow the escape of the fluid without the removal of the pellicle, which is the best protection of the injured surface. The local applications should

[1] T. Billroth. [2] T. Smith. [3] T. Bryant. [4] S. D. Gross.

soothe the irritated parts and protect them from the air; for this purpose the following remedies may be used, according as they are at hand: equal parts of linseed oil and lime-water on lint, and covered with cotton-wool: carbolized oil; a complete covering with flour; white lead in the form of paint;[1] zinc ointment on lint. (3.) In this form the destruction is deeper and the eschars, or sloughs, result with varying degrees of suppuration. If the surface involved is considerable, reaction will probably not occur, and death will soon follow. If limited in extent, the early treatment must be directed to relief from the shock, and then to the immediate dressing of the surface. The second dressings must be applied with reference to the separation of sloughs, and the most important is the carbolic acid dressing, as follows: carbolic acid, one ounce to a pint of olive or linseed oil, or an ointment made of carbolic acid ʒiv., lard ʒiv., and castor oil ʒi.;[2] to the other surfaces involved, apply the oil and lime-water, or zinc, or creosote ointment gtts. x. to lard an ounce; or a lotion of tr. iodine ʒi. to water one pint. When the sloughs separate, ulcers are left, which heal very slowly by granulation. The slow process of healing is attended with contractions of the cicatricial tissues, which tend powerfully to cause distortions and result in disfigurement and impairment of the functions of the parts involved. The most efficient preventive measure is elastic extension by rubber straps, so applied as to maintain gentle, but firm, resistance to the contraction, without pain or inconvenience.

CHAPTER XXVIII.

DISEASES OF THE TEGUMENTARY SYSTEM AND SPECIAL OPERATIONS.

I. THE SKIN.

The epidermis and papillary body form the more superficial portion of the integument, the former being an insensible covering of flattened cells, while the latter is richly supplied with vessels and nerves, and reacts to stimulants by hyperæmia and inflammation; the two constitute a vegetative whole, the latter being the matrix of the former, through the constant supply of young cells; a morbid sub-activity of this process results in various hypertrophies of these tissues.[3]

1. **The callosity** is a circumscribed thickening of the horny layer of the epidermis, and consists of many strata of epidermic scales superimposed on one another, the deeper resting on the rete muco-

[1] S. D. Gross. [2] J. Lister. [3] E. Rindfleisch; F. Hebra.

sum; it increases gradually by the continual addition of new epidermic tissue from below, and finally develops into a plate which steadily becomes more elevated; its consistence depends upon its moisture, and varies from the elastic and flexible to the horny and brittle; it appears on parts of the skin exposed to a frequently recurring but not continuous pressure, and which rests on bone, as the heads of the metacarpal and tarsal bones; they sometimes form as large and painful plates on the sole or palm.[1] The treatment consists in removal of the growth and prevention of its recurrence; after prolonged soaking in hot water, apply glacial acetic acid, or nitrate of silver, and detach the plates which form;[2] protect the part from pressure of the substance which caused the original thickening.

2. **The corn** (Fig. 250) is a callosity so modified by the yielding of the deeper parts to the external pressure that the deep layers assume the form of a nail (Clavus) with its point penetrating the cutis (Fig. 250); the external elevation is small, but the swelling from the under surface of the thickened horny layer forms a truncated cone with the axis at right angles to the surface of the skin into which it has penetrated for some distance; like the callosity, it varies in consistence with the degree of moisture, on exposed surfaces being hard, but between the toes soft; a bursa may form when the corn penetrates the skin.[3] The treatment is the same as for a callosity.

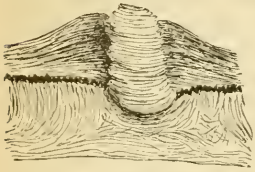


Fig. 250.

3. **Warts,** Verruca, are overgrowth of the epidermis, in which the papillary body shares more or less; the common hard wart consists of a circular group of elongated papillæ, with their free extremities slightly enlarged and bulbous, their vessels dilated and extending close up to the epidermic covering.[3] The treatment should be, (1) an effort to turn the wart out by pressure with the finger-nail, which frequently succeeds with dry warts on the face, and moist warts on the genitals;[1] (2) excision with knife or curved scissors, and cauterization of the base with chloride of zinc; (3) destruction by caustics, as chloride of zinc, nitric acid; (4) dessication by applications of tr. iodine or acetic acid.

4. **The cutaneous horn** results from hypertrophy of a group of papillæ; in its growth it may involve hair sacs and contain sebaceous cysts.[3] The treatment is extirpation.

5. **Erysipelatous inflammation** is located chiefly in the papillary layer and in the rete Malpighii; any part may be attacked, but it is most frequent in the head and face; the local symptoms are

[1] F. Hebra. [2] Ormsby. [3] E. Rindfleisch.

great redness and œdematous swelling of the skin, pain on being touched, and high fever; it lasts from one day to three or four weeks. The treatment, is laxatives to improve the digestive organs; then give tonics, as quinine and iron; good diet; locally, light scarifications are often useful, followed by lead and opium lotions; if pus form it must be evacuated.

6. **The furuncle, boil,**[1] seems to have its origin in the death of a small portion of skin, or perhaps of a cutaneous gland, which becomes the centre of an inflammation; by infiltration with plastic matter the tissue of the cutis partly turns to pus and partly becomes gangrenous; the peculiarity of this form of inflammation is, that it shows no tendency to spread, but remains circumscribed, and terminates in the detachment of the central dead tissue; regions where the secretions of the cutaneous glands are particularly strong are predisposed to furuncles, as the axilla, perineum; they occur more often in the emaciated and feeble, but may appear in the robust and well-fed.

There are also constitutional conditions and diseases which dispose to the formation of boils, creating a diathesis, furunculosis, which may prove very exhausting, especially to children and old persons.

The disease appears first as a red and rather sensitive nodule in the skin, size of a pea or bean; soon a small white point forms on its apex; the swelling spreads around this centre, and usually attains the size of a dollar; towards the fifth day the central white point becomes loosened, and is evacuated as a plug with pus mixed with blood and shreds of tissue; suppuration ceases in three or four days, and the cavity cicatrizes. The abortive treatment with ice is not advisable; warm, moist applications should be made, as poultices, to hasten suppuration, and an early opening be made to relieve tension and evacuate the contents. Select a lancet having a fine point and a broad, sharply-cutting shoulder; plunge the point nearly vertically to the surface (Fig. 251) so deeply as to reach the pus, and then cut outwards. To the debilitated, give quinine, iron, wine, nutritious foods.

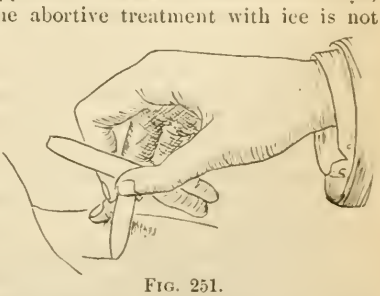


Fig. 251.

7. **Carbunculous inflammation, anthrax,**[1] anatomically resembles several furuncles lying close together, but the process is more intense and inclined to spread; their chief seat is the hard skin of

[1] T. Billroth.

the back, especially in old people; they first appear like the furuncle; but soon a number of white points form near each other, the swelling, redness, and pain increases, and the carbuncle may attain the size of a soup-dish, while plugs and gangrenous shreds are detached, until the skin appears perforated like a sieve; the process is almost always limited to the skin and subcutaneous cellular tissue, fasciæ, muscles and arteries rarely being destroyed; after the separation of the cellular tissue and arrest of the process, luxuriant granulations appear and healing progresses favorably. Carbuncle of the back is tedious and painful, but rarely causes death. The disease may, however, attack other parts, as the lips, or cheeks, or head, and prove rapidly fatal; in many cases of malignant carbuncle the inflammation extends to the cranial cavity; but in other, and the more quickly fatal, cases, the brain is not affected, and the probability is that there is a rapidly-occurring decomposition of the blood of which the carbuncle may be the cause or the result.

This decomposition may have its origin in infection conveyed by an insect which has previously been on carrion; the high fever and fatal blood infection are mostly results of the local disease.

The ordinary carbuncle of the back is easily recognized by its broad inflamed base with perforations of the skin; on the lip, face, or head, it may be mistaken for erysipelas, but is readily distinguished by its hardness, purplish color, severe pain, high fever. The treatment of all forms of carbuncle must be very energetic to prevent the spread of the disease; numerous incisions should be made early to permit the escape of the decomposed putrid tissues and fluids; they should be crucial in form, through the whole thickness of the cutis, and extending to the healthy skin; the applications to the exposed surfaces should be strongly disinfectant, as strong carbolic acid solutions, creosote, chlorine water, or turpentine; hot poultices may be added to hasten suppuration unless they aggravate the pain or the head symptoms. The general treatment should be actively supporting ; wine or whiskey as stimulants ; quinine and iron ; opium both to relieve pain and promote capillary circulation,[1] and easily digested nutritious food.

8. **Phlegmonous inflammation, cellulitis,**[2] may occur in any part of the body, but is most frequent in the hand, forearm, knee, foot, and leg; the cause is often obscure, but it may arise from injuries, infection, cold: the spontaneous form is more frequent in the extremities, above than below the fasciæ, and is especially prone to affect the fingers and hand, about the nails, panaritium. The disease is a serous exudation from the vessels, and infiltration of the connective tissues with quantities of young, round cells; it begins with

[1] F. C. Skey. [2] T. Billroth.

pain, swelling, and redness of the skin, and usually with high fever; the tissues become tense, there is stagnation in the vessels at various points, especially in the capillaries and veins, and in some parts the circulation ceases entirely, resulting in extensive gangrene of tissues; as the inflammation spreads the entire inflamed part is changed to fluid matters, consisting of cells, with some serous fluid mixed with shreds of dead tissue; the process, finally, involves the skin, perforates it at some point, and the pus and debris escape externally. The inflammation now ceases to extend, the walls of the cavity unite, and the plastic infiltration of the part is finally absorbed, and the tissues return to their normal state. Or, the case may terminate fatally, owing to the absorption of the putrid products of suppuration, as in deep collections about the neck of old people. The treatment aims to arrest the development of the disease by securing the earliest possible absorption of the serous and plastic infiltration; for this purpose light scarifications may be made, or ice may first be used, or mercurial ointment well rubbed in, followed by enveloping the part with warm, moist cloths or large poultices; if these fail, suppuration must be hastened by hot poultices; the pus should be evacuated as soon as detected, and from several punctures if it is diffused.

If the pus lie deeply in vascular parts, as the neck, the opening should be made, not by plunging a bistoury into the swelling, but by careful dissection, or after the skin and fascia are incised, by working a blunt instrument, as a director, cautiously through the structures, and when pus appears, introduce the blades of forceps and expand them.[1]

9. **An ulcer**[2] is a wounded surface which shows no tendency to heal; it mostly starts from chronic inflammation, and is always preceded by cellular infiltration of tissue; two opposite processes are combined, namely, new formation and destruction, the latter resulting from liquefaction of tissues through suppuration or molecular disintegration or both; two classes of ulcers result from this antagonism: (1) those in which the new formation predominates, proliferating ulcers, and (2) those in which suppuration and disintegration are most prominent, atonic or torpid ulcers. For the purposes of description the following forms are recognized: (1) The erethitic or irritable ulcer, which constantly has red and sensitive borders, bleeds readily, and the granulations are painful to the touch; the proper treatment is the destruction of this surface with nitrate of silver or the hot iron, and the subsequent compression with adhesive plaster; the hot iron is but slightly painful; if this treatment is not practicable, zinc ointment or lead lotions may be used, or other mild salves; (2) fungous ulcers exist when the granulations project above the level of the skin and are proliferating; the treatment requires that the surface of the

[1] J. Hilton. [2] T. Billroth.

granulations shall be destroyed by caustics, as the solid nitrate of silver or the hot iron; milder remedies are, compression with adhesive strips, and astringents, as oak bark, alum, Peruvian bark; (3) callous ulcers have thickened and hardened margins, owing to the long duration of chronic inflammation; the ulcer is torpid, lies deeply below the surface, with sharply rounded edges, and the surface is glazed. In treating the more tractable cases the indications to be met are, to soften the hardened borders and base, and to induce a proper amount of vascularity in these parts; the former is most thoroughly effected by the hot iron, or by strapping with adhesive plaster cut into long strips and applied partially around the limb and very firmly over the ulcers, drawing its edges down and towards each other; the second is best accomplished by moist warmth, as poultices or the continued warm bath.

It is not always possible to obtain healing of a callous ulcer of the leg, especially when it is situated on the anterior face and extends to the periosteum of the tibia, or when it surrounds the leg like a ring.

10. **Lupus**[1] commences with small nodules in the superficial layers of the skin, more often on the face, especially on the nose, cheeks, and lips. They may enlarge and run together so as to form large nodules and tuberculous thickenings of the skin, L. hypertrophicus; or there may be a free exfoliation of epidermis on their surface, L. exfoliatus; or the surface may ulcerate, L. exulcerans; with strongly proliferating granulations, L. fungosus; or with rapid destruction of tissues, L. exedens.

The process commences essentially in the connective elements of the cutis, with very abundant new formation of vessels; the cutis at first becomes converted into separate, entirely circumscribed nests; then more diffusely into a layer of small cells which does not differ essentially from a common granular tissue; the cells have the form and size of the white elements of the blood, and often form under the mucous layer as sharply defined, large, round, or oval masses.

The disease must be classified with new growths, consisting of granular tissue, characterized by such a copious aggregation of small exuberant cells that the elements of the cutis, and not infrequently of the still deeper-seated layers of cellular tissue, are completely displaced and destroyed by them; this infiltration soon results in complete substitution, and if the exuberant cells disappear, there is permanent loss of substance which may appear as a special defect, or a contraction of parts, or sometimes as a scar; the disfigurements of lupus may, therefore, occur without as well as with open ulcers, for as the infiltrated parts recover they shrink to less than their former volume, as does ordinary cicatricial tissue, the skin appearing to be

[1] R. Volkman.

interwoven, with irregular, cicatricial lines, which may even acquire an irregularly filled surface.

The treatment is exclusively local, and aims to remove every nodule: (1) by destroying affected tissues, and (2) by effecting in parts still firm and comparatively healthy the absorption of the lupoid cellular infiltration. The most effective method is as follows: for the removal of parts entirely converted into lupoid tissue, use sharp scoops; give an anæsthetic, and with the scoop scrape off or out all soft structures until the part is entirely free from the diseased structures; the necessary force may be employed for the scoop will only remove diseased tissues; touch the surface lightly with the solid nitrate of silver, and cover it with small pieces of lint which should be allowed to dry, or cold applications may be made. For the removal of diffuse lupoid infiltrations with preservation of the layers of the skin resort to multiple punctiform scarification, as follows: the patient being under an anæsthetic, with a narrow-bladed, sharp-pointed knife, make hundreds or even thousands of punctures two or more lines in depth, close to each other; in many cases the skin after the completion of the puncturing appears of a lead color, or even suspiciously white, and resembles chapped flesh: but gangrene never has ensued; cover the part with lint, press it on firmly to stop bleeding, and leave it until it falls spontaneously; repeat the operation three, five, or even eight times if necessary, at intervals of two to four weeks; the skin gradually becomes firmer and loses its abnormal swelling and redness, while no cicatrices are formed. If this treatment is rejected, caustics must be used; of these, the caustic potash, or nitrate of silver in the stick, may be selected.

The attached crusts must first be removed by applying cod-liver oil one or two days; then bore the caustic stick into the soft lupoid granulations, retaining the potash in contact with the tissue much less time than the silver; wipe off the syrupy, tar-like mass with pads of wadding until a sound, firm surface appears; now cease to apply the caustics, for if the application is continued the erosions will be too deep, and disfiguring scars will result; apply simple dressings.

11. **Elephantiasis arabum** is an hypertrophy of the corium and subcutaneous connective tissue, beginning with an inflammatory stage, during which the lymphatic glands become swollen, and the lymph-paths through them permanently blocked, and resulting in stasis of the lymph, and hypertrophy. The treatment is rest, with the use of the elastic bandage for a long period; or ligature of the main artery to the limb;[1] the chief nerve of the limb has been divided with good results.[2]

[1] J. M. Carnochan. [2] T. G. Morton.

12. **Soft fibrous or connective tissue tumors**[1] are composed of a very tough, somewhat œdematous, white tissue, and are usually covered with the thin papillary layer of the cutis; on the surface there are almost always pointed papillæ. Even when the tumor is developed in a part of the skin which normally has no papillæ, they usually hang loosely and are often, distinctly pedunculated; the growth is slow, free from pain, and may develop into enormous tumors, and may be multiple; they occur towards the end of middle life, and are often found in women on the labia majora. The treatment is extirpation.

13. **Sarcomata**[1] of the skin are generally spindle-celled, and may be alveolar or melanotic; they usually ulcerate early, without, however, extensive destruction; they develop with peculiar frequency after precedent local irritations, especially after injuries; cicatrices are not unfrequently the seat of these tumors; black sarcomata may come from irritated moles. The diagnosis is often difficult, owing to the variable characters which they assume; they are generally of slow growth, free from pain, occur in middle life, and their location is at irritated points. The treatment is extirpation.

14. **Epithelioma, squamous, of the skin,**[2] begins as a flattened and indurated elevation of the surface, and extends progressively both in depth and superficial area; when it reaches a certain maximum of development at its place of origin it breaks open at this point; the somewhat tuberculated surface grows rough, erosions, fissures, and holes appear in great numbers, and exude a white, inodorous, pulpy fluid mixed with pus; it next falls in at its centre, and a hollow is produced which is henceforth marked, either by the dried secretions, or, when these are removed, by the sloughy shreds of the original tissue; it now has a hard base, and hard, raised edges; at the periphery the infiltration advances into the neighboring parts, while in its centre there is disintegration, and the phenomena of repair.[1] The most frequent seat is the face, especially the cheeks, brow, nose, and eyelids; the genitals, as the penis, the clitoris, the neck of the uterus. The treatment is extirpation by free incision, for this variety does not belong to the most malignant group of morbid growths; within a year the cicatrix usually becomes the seat of a new analogous growth, but cases occasionally occur in which the disease has not returned after radical extirpation.

II. THE HAIR AND GLANDS.

1. **Overgrowth of hair**[2] can only be said to exist in hairy moles; these brown, hemispherical or flattened elevations seem to offer peculiar facilities for the most luxuriant growth of hair;

[1] T. Billroth. [2] E. Rindfleisch.

not only are the individual hairs very stout, but they are shed and renewed much oftener than those of the head and beard. A vertical section shows at least one fourth of the hair-follicles very thickly set and furnished with a little accessary sac occupied by a new hair in a more or less advanced stage of development. When the growth is a serious deformity, excision may be practiced, or it may be removed by caustics,[1] as follows: The surface being shaved, apply the disk-shaped cautery at a red heat on the surface until a dark, brownish eschar is produced; then immediately apply compresses wet in ice-water, and renew them frequently; by this means the patient suffers but little pain on coming out of the anæsthesia, the eschar separates in due time, and the granulation growth is kept level with the neighboring skin by the application of nitrate of silver. Or, the solid caustic potassa may be rubbed into the surface till the skin becomes a disorganized pulpy paste, its action being checked by dilute vinegar.

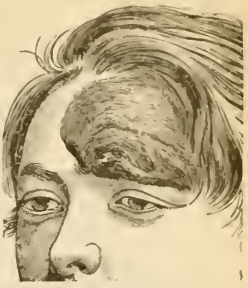


Fig. 252.

2. **Retention of secretions of the hair-follicles and sebaceous glands,**[2] gives rise to a variety of affections commonly known as wens. The cause of retention is often a closure of the hair-follicle by over-secretion of epidermis and tumefaction of the subepidermic connective tissue about the mouth of the hair-sac. The retained secretion may often be squeezed out when it assumes the form of a worm, comedones; in other cases it has the appearance of honey, creating another variety, meliceris. The treatment, when they become large and troublesome, is extirpation: the dissection need not be carefully made, as it is not necessary to preserve the sac entire; when the capsule is reached it may be bisected and each half removed separately by evulsion; seize the edge with strong forceps and forcibly detach each portion.

3. **Acne rosacea**[3] consists of retention of secreted matter on one hand and a perifollicular inflammation on the other; the sac of connective tissue appears to be converted into pus, while hyperæmia, plastic infiltration, and suppuration follow one another in an area extending from half a line to two lines from the follicle. The growths have assumed such size (Fig. 253) by hypertrophy of the connective tissue

Fig. 253.

[1] G. Buck. [2] E. Rindfleisch. [3] C. Wagner.

as to require excision.[1] In the operation for the removal of the tumors, divide the pedunculated ones close to the cartilage; from the sessile growths remove slices by elliptical incisions, and dissect out from under the skin the hypertrophied tissue, care being taken to leave sufficient flap to cover the cartilage; close the wounds with fine silk suture. (Fig. 254.)

Fig. 254.

II. THE NAIL.

The nail consists of the flattened cells of the papillæ of the posterior part of the matrix, and of the mucous layer of the beds of the matrix; the former are pushed forwards along the beds in ridges, and the latter are added to the under surface of the nail.[2]

1. **Inflammation**, acute, may follow injuries, as blows, the penetration of sharp bodies; the chronic is caused by syphilis, eczema, psoriasis; the result may be irregular growth of the nail, or its destruction by suppuration and ulceration; in unhealthy children the inflammation may be followed by the ulceration of the matrix. The treatment should be to relieve the inflammation by the removal of the cause, and such general and local remedies as the special conditions demand.

2. **Atrophy and hypertrophy**[3] depend upon the same conditions, namely, general diseases, as syphilis; local skin affections, as eczema, psoriasis; injuries, as pressure, blows, penetration of splinters, needles; trades, as hatters, gilders; fungi, as favus. In atrophy the function of the matrix is diminished, and the nail may become thin, small, narrow, soft, or be wholly lost. In hypertrophy, the functions of the matrix are increased, and as a consequence the nail may be of unusual length and width, appearing as if too small for its place; or the substance of the nail may be thickened throughout, but most considerably in front, having the shape of a chisel, with its thick base forward; or the thickening may chiefly affect the middle portion, so that it is elevated in the form of a cone or wedge raised in a shapeless lump, often continued in a long, straight or curved, tap-shaped excrescence. The treatment of these affections is the same so far as they depend upon the same conditions. All sources of local irritation should first be removed; syphilis requires the ordinary general treatment, and the local application of mercurial plaster wound round the ungual segment of the finger or toe, so that it compresses the fold of the nail. Non-syphilitic affections require the same treatment as in other parts, but special effort must be made to secure the effect of the remedies upon the matrix

[1] C. Wagner. [2] Virchow. [3] T. Annandale.

and bed of the nail. In hypertrophy, India rubber worn upon the part soon macerates the epidermis and diminishes hyperæmia of the papillary layer.[1] The local treatment should aim to remove such excrescences as are deformities and annoyances, by means of scissors, the knife, bone-nippers, or a fine saw, care being taken not to extract the nail from its bed.

3. **Ingrowing** is a curving downward of the margin of the nail, and in general is found on the external border of the nail of the great toe; it is due to the pressure of tight boots or shoes, and especially when the nail is hypertrophied; the fold of the nail becomes inflamed, the skin ulcerates, red, spongy granulations appear, and the part becomes exquisitely tender; the ulcerative process may extend backward, and finally the matrix and the whole end of the toe may be involved in the inflammation. The treatment at first should consist in attempts to heal the ulcerated point where the nail penetrates the skin. Of the various methods proposed, select the following: Cut dossils of charpie, having parallel threads, of the length of the lateral fold of the nail, or rather larger; lay it on the nail parallel with the fold; by means of a flat probe push the mass down, thread by thread, between the swollen inflamed fold and the border of the nail, so as to completely separate the skin and the nail; pad around the furrow of the nail with charpie; apply long strips of adhesive plaster one and a half lines wide around the toe, from above downwards as regards the inflamed fold; repeat this dressing daily, if necessary.[2] When the inflammation involves the whole fold and extremity of the toe, extirpate the portion of the nail involved, as follows: with sharp pointed scissors, slit up the nail, (Fig. 250) then seize the offending portion, and with a slight twist remove it from the matrix[3] (Fig. 251).

Fig. 250.

When the inflammation extends completely around the nail, the entire nail should be removed and the matrix excised.

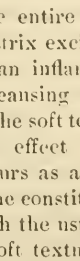


Fig. 251.

4. **Onychia**[4] is an inflammation of the matrix of the nail, causing ulceration, and gradually involving the soft textures around; it is sometimes the effect of injury, but more frequently occurs as a result of some unhealthy state of the constitution; the simpler forms begin with the usual signs of inflammation in the soft textures around the nail, which become red, painful, and swollen; the nail itself becomes affected, and its margins roughened and displaced; suppuration and ulceration follow, and a sore is formed which is often kept in a state of irritation by the uneven margin of

[1] Hebra. [2] Kaposi. [3] Dupuytren. [4] T. Annandale.

the nail pressing against it; the nail is loosened, its edges and root roughened and raised up. In its most severe form, onychia maligna, it occurs in children, generally after slight injuries; the whole soft textures around the nail and at the extremity of the fingers become red and swollen, giving it a bulbous appearance (Fig. 257); the discharge is thin and fetid, the nail is loosened, and the bone may be expanded. In the mild form use nitrate of silver to arrest the ulceration, and remove the nail if it keeps up the irritation. In the severe forms, remove the nail at once, and freely cauterize with caustic potassa, nitric acid, or nitrate of silver. The nail is best removed as follows: The patient being under an anæsthetic, thrust the sharp point of strong scissors under the nail and through the matrix (Fig. 255); now seize one section of the nail with strong forceps (Fig. 256), and by sudden eversion tear it from its position.

Fig. 257.

Fig. 258.

Fig. 259.

5. **The claw-like nail**, onychogryphosis, depends upon a hyper-plastic state of the entire matrix of the nail (Fig. 258); the long, horizontal papillæ furnish nearly all the substance of the nail, which is no thicker at the finger-tip than at the edge of the lunula; this gives the nail its ridged appearance, each ridge corresponding to a papilla.[1] The only reliable remedy is complete removal of the nail and its matrix,[2] with such general treatment as the case requires.

6. **Horny growths** (Fig. 259), resembling exostoses, sometimes appear at the margin of the great toe, and create much suffering. The only treatment is excision.[2]

7. **Psoriasis**[3] appears as a thickened, rough, scabrous, and unusually convex condition of the central portion of the nail; the free edge is often split, and the cuticular fringe at the bottom of the nail is ragged and retracted; the whole nail resembles the concave shell of an oyster. If it is caused by syphilis, give mercury in small doses for a long period; if not specific, give arsenic with a tonic. The appearance of the nail is improved by smoothing with glass or sand-paper; or by friction, with dilute acetic acid.

[1] E. Rindfleisch. [2] T. Bryant. [3] T. Smith.

CHAPTER XXIX.

GENERAL OPERATIONS ON THE TEGUMENTARY SYSTEM.

THE SKIN.

Thermometry[1] is generally practiced upon the skin to determine with exactness the state and variations of bodily temperature, and is an important mechanical aid in diagnosis.[2] Two kinds of instruments are now employed, one, *b*, *c*, to be used in enclosed cavities, and the other, *a*, upon the surface of the integument. Many varieties of the former instrument are now in use, but the straight, self-registering, clinical thermometer (Fig. 261) is recommended for general use.[2] Thermometers are also made with spiral tubes and a constriction in the stem a short distance from the bulb, to prevent the index from passing into the bulb when jerking the instrument to bring the index below the normal. An indispensable condition for accurate investigation is that the instrument itself be accurate; to determine this question, the thermometer should be tested by placing it in a water-bath with a standard thermometer and the variation noted; as the glass changes by use it is found that clinical thermometers change, and hence it is desirable to repeat the test occasionally. The same thermometer should be used continuously on the same patient. Before making an observation of the temperature of the body, the thermometer should first be examined to ascertain the position of its index or the detached portion of the column of mercury in the tube separated by a very minute portion of air; if the bulb is warmed the ascending column of mercury will be seen to push the index before it, but not to touch it; upon cooling the bulb, the column withdraws and leaves the index at the maximum temperature attained; the index being a portion of the column of mercury, that end of it most distant from the bulb indicates the temperature; if the index is found to be above ninety-eight degrees Fahrenheit, it

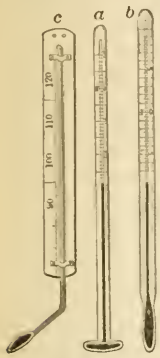


FIG. 260.

FIG. 261.

[1] C. A. Wunderlich. [2] A. L. Loomis.

should be shaken down until it is at least two or three degrees below that point, say ninety-five degrees.

The shaking of the index from a higher to a lower point in the scale of the instrument is often a matter of some difficulty; there are three ways of accomplishing it.[1] The index of mercury is prevented from sliding backwards and forwards in the tube of the instrument, as each end of it is raised or depressed, by the law of capillary attraction; to overcome this it is necessary to give to the index an impetus capable of counteracting the attraction of the sides of the enclosing tube; this may be done by holding the instrument between the thumb and index finger, about the upper fourth of its length in a line continuous with the arm, then raise the forearm until the thermometer is as high as the shoulder, and bring it down with a rapid swing or jerk in a line with the body; this motion, if vigorously executed, will have the effect of propelling the index toward the bulb at the rate of two or more degrees for each movement; this should be repeated until the index points below ninety-eight degrees. Another method is to seize the tube about the middle, between the thumb and finger, with the bulb downwards, and to strike the wrist or edge of the palm of the hand upon the other hand; this, if sharply done, will have the desired effect. There are, however, disadvantages to this method. When in cold weather the mercury has retreated into the bulb, and the thermometer is jerked in this way, the mercury is liable to be forced up the tube and there form one or more indices; but a more serious objection is, that the tube may be split, for when the mercury is so suddenly forced into the small, empty conical chamber above the bulb, in a quantity and at a speed that the tube cannot relieve it quickly enough, it acts like a wedge and produces a minute fissure, usually in a line with the enamel. If this fissure exist, the tube should be held at different angles, when it will be seen as a segment of Newton's rings extending to near the edge of the tube. A third method is to hold the thermometer as at first by the upper fourth of its length, between the thumb and finger, but horizontally and at right angles to the forearm, then bring it down with a quick rotation of the wrist, somewhat accelerating the motion by the downward action of the arm at the same moment.

The introduction of this instrument into the well-closed axilla appears to be the most convenient method in the great majority of cases; its use in this situation is attended by scarcely any difficulties, and no objection can be made on the score of decency.

The application of the instrument in the inside of the mouth apparently affords uncertain indications, because the cool air inspired may easily lower the temperature; but the mouth must be employed when other parts are inaccessible; taking the temperature in the rectum and vagina is repulsive, and can seldom be repeated often enough, and is to be resorted to only in infants, in the emaciated, during collapse, and other special circumstances.

Use it as follows: If the axilla is wet with perspiration wipe it dry; press the arm against the side to close the cavity for a few minutes, all clothing being removed from it; warm the whole instrument in the hand to 85° F. or 90° F.; now place the bulb deep in the axilla behind the anterior fold, the stem inclining upwards, and

[1] T. H. Hawksley.

close the axilla by pressing the arm firmly against the chest; the arm should be firmly held in position, the stem being lightly covered with the clothing. The instrument should be accurately retained in the closed axilla at least five minutes; on removing it note the point of elevation or depression of the upper end of the column. The circumstances of the case and the objects sought to be attained must decide the question of time and frequency of the observations: it is desirable to repeat the observation at a similar time each day; usually it is sufficient to make the observation twice daily, which is best done between seven and nine A. M., the period of probable lowest daily temperature, and in the evening, between four and six o'clock, the period of probable highest daily temperature.

The surface thermometer must have its broad extremity placed upon the part to be examined, and be held in position about five minutes.

The variations of temperature and rate of radiation of any part of the surface may be accurately determined by the thermoscope (Fig. 262).[1] It consists of a glass tube seven inches long with a minute bore, open at one end, and terminating at the other in a bulb; an adjustable scale is attached to the outside of the tube. Prepare it for use as follows: immerse the bulb in hot water to rarefy the air inside; then plunge the open end into cold water and quickly withdraw it, when a drop or two will be found to have entered the tube, and will form a water index which should become stationary within an inch or two of the bulb; adjust the scale, bringing its lowest figure on a level with the top of the column of water in the tube. It may be applied to any surface, and registers the volume of heat escaping by radiation and the velocity of loss.

Fig. 262.

2. **Rubefacients** produce intense irritation, redness, and congestion; their effect is temporary, and in proportion to the extent of surface covered; they are preferable to blisters to arouse the system.[2]

Mustard is used in the leaf with vinegar, as essential oil, as a flour sprinkled on a wet cloth, or laid on paper sinapisms, or as common paste, made by adding water of the temperature of 90° to 160° F. Linseed or Indian meal may be added to diminish its action; one part of mustard to sixteen of meal will make a slightly irritating poultice, which children with acute diseases of the lungs will wear continuously with great benefit; remove the mustard before the skin is broken, wipe the surface with a wet cloth, and dress the part with cotton-wool or well-oiled cloth. Make the application directly to the skin when prompt action is required, but interpose a thin cloth when more permanent effects are sought. An artificial essential oil of mustard may be used, namely, sulphocyanide of allyl in solution in alcohol, one to fifty. Capsicum may be used in a poultice, or on cloths wet with a strong watery solution.

Turpentine is a highly stimulating application, and may be used as a liniment,

[1] E. C. Séguin. [2] H. C. Wood.

or sprinkled on a wet cloth; it reddens the skin very promptly, and the surface requires no other attention. Dry-cupping draws the blood to the skin, where it remains many hours, relieving deep-seated congestion; apply the cup with an exhaust pump, or use the common cupping-glass, or a small tumbler, or other accessible cup; moisten the internal surface with pure alcohol; ignite with a burning wisp of paper, and invert the cup on the part. Croton oil causes a fine pustular eruption, and is applied by rubbing briskly one part of oil to three parts of olive oil, and repeating carefully, limiting it to the part. Potassio-tartrate of antimony, tartar emetic, causes a large pustular eruption, and is applied as an ointment, well rubbed into the skin; the surfaces are to be dressed as after the application of mustard. The strong tincture of iodine repeated several times, and nitrate of silver, in concentrated solution, or mixed with lard, produce desquamation.

3. **Vesicants** are more permanent in their effects than rubefacients; their local action consists in first diminishing and then destroying the vitality of parts with which they are brought in contact; this local action is depletory, as by increasing the amount of blood in the tissues immediately under the blistered surface, the deeper subjacent structures are rendered very anæmic; they also affect the heart through the nervous system, the weak applications strengthening, and the powerful depressing its action.[1]

There are many agents which may be made to act as vesicants, as cantharides, ammonia, hot fluids. Cantharides acts most promptly on the young, and on parts where the integument is thin. It may be used in the form of blistering liquid, cantharidal collodion, applied with a brush, or of tissue, or of the officinal emplast cantharis. The surface to which it is to be applied should be cleansed, and if there is liability to strangury, dusted with camphor, or covered with oiled tissue-paper. Fresh cantharides will vesicate within three to five hours; if not fresh, vinegar applied to the skin or plaster will often hasten its action. The redness of the surface and small blisters, are evidence of the action of the vesicant; the application of cloths wrung out of hot water, or a poultice, causes immediate effusion of serum; open the blister with a needle at the most depending part; allow the cuticle to fall upon the surface underneath; dress the surface with oil or simple cerate. To make the effects of the blister more permanent, remove the cuticle and apply stimulating substances, as the leaf of the cabbage, beet, ivy, or savin ointment. To vesicate quickly, apply chloroform on cotton covered by a watch-glass or saucer; or liquid ammonia on a swab, or hot water. A heated iron, thermal hammer, dipped in water of 120° F. and applied to the skin two or three seconds, is a rubefacient, and continued five to ten seconds is a vesicant. If excessive inflammation, or erysipelas, follow the blister, apply poultices of bread and water or flax-seed.

4. **The endermic application**[2] of remedies is frequently preferable to administration by the stomach or hypodermically. The method consists in introducing the substance into the skin by rubbing, inunction, or occasionally it will be useful to remove or to irritate the cuticle, and to apply the remedy to the denuded or reddened spot. Morphine and quinine may be thus applied; but they must be

[1] A. W. Hollis. [2] W. Bernatzik.

used in quantities about one third larger than when applied hypodermically. Mercurials are generally applied to the unbroken skin, for instance, the ung. hydr., or ung. hydr. nitrat., or the oleate of mercury. Solutions of alkaloids in oleic acid, such as the oleates of morphia, aconitia, veratria, atropia, and quinia, are very readily absorbed. The quantities usually employed for a single application are the following: morphia, one sixth to one half grain; veratria, one twelfth to one third grain; strychnia, one twentieth to one twelfth grain; atropia and hyoscyamia, one sixtieth to one twentieth grain.[1]

5. **Acupuncture** is a method of counter-irritation effected by passing slender needles into the part, and allowing them to remain from a few minutes to several hours. The needle should be of steel, from two to four inches in length, polished, very sharp-pointed, flexible, and soft, having a metallic head. (Fig. 263.)

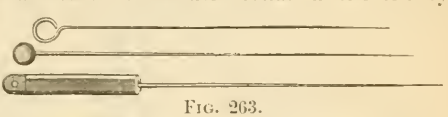


Fig. 263.

They are inserted by making the skin tense with the left hand, and with the right introducing the needle, with a rotatory motion, to the required depth, avoiding joints and viscera. They may safely penetrate several inches, and have even been introduced into viscera without ill effects. They are liable to become oxidized, and on removing them pressure should be made upon the adjoining surface, while the needle is rotated slightly.

An instrument has been devised to introduce a vesicatory liquid beneath the epidermis.[2] The piston containing the needles is adjustable in its cylinder, which holds the medicinal preparation: the needles project through the diaphragm to the required extent, and the epispastic liquid insinuates itself along with the needles into the punctures. Another form of acupuncturator[3] (Fig. 264) has a regulating nut, *g*, to adjust the depth of penetration of the needles which project through the diaphragm to conduct the liquid from the cylinder *A* and introduce it through the skin; the needles *b*, *e*, are stacked in the piston *B*, whose stem *d* is sleeved in the stem screw *c*, *f*.

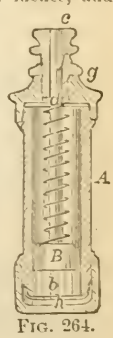
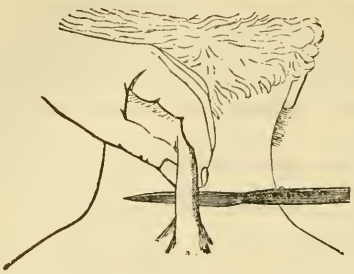


Fig. 264.

6. **The issue** is a suppurating wound of the deeper structures of the skin. It may be made with a seton, incision, caustic, or moxa, and must be so limited as not to extend its action beyond the subcutaneous areolar tissue. Apply them at points as free as possible from local irritation, and remote from large vessels and nerves, as the nape of the neck, the insertion of the deltoid on the arm, the external part of the thigh and internal part of the leg. The seton may consist of a few threads, a piece of linen, or of lamp-wicking, or, what is now more frequently used, on account of cleanliness, a

[1] C. Rice. [2] Fiermenich. [3] Klee.

strip of India-rubber cloth. The instruments required for its introduction are either the seton needle (Fig. 265) or a straight bistoury, and a probe having an eye. Pinch up a fold of the skin corresponding with the direction of the muscles of the part, or vertical with the body, pass the needle, armed



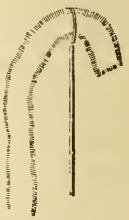


Fig. 265. Fig. 266. Fig. 267.

with the seton, deeply through the parts, but without involving tendons or muscles; draw the seton through and tie loosely. If the bistoury and eyed-probe are used, pinch up the integuments and transfix with the bistoury (Fig 266); pass the probe having the seton through the eye, or attached by a thread (Fig. 267), through the wound, and tie. The subsequent dressings consist of greased lint, and a bandage around the part to be exchanged for a poultice when suppuration commences. The seton must be drawn through daily, and the part saturated with pus cut off. When an issue is made with the knife, the incision must penetrate into the subcutaneous cellular tissue, and a foreign body, as a pea, or a small bead, is introduced and retained by adhesive straps until suppuration is established. The caustic may be the actual cautery, or Vienna paste, or other powerful escharotics. In shape, the iron cautery should have a more or less flattened surface, when it is required to produce a superficial slough, or conical when it is required to penetrate more deeply (Fig. 268). If it is applied at a white heat, and firmly pressed upon the part until an eschar is formed, although not severely painful, local anæsthetics should be used; cold-water dressings should be applied for several hours, followed by moist warm applications, as a poultice, until the slough separates. Vienna paste is prepared by triturating equal parts of quicklime and caustic potassa; it is applied to the part, of the required size, and allowed to remain ten or fifteen minutes; when removed, wash the surface with diluted vinegar, to counteract its action. Caustic potassa may be used in a similar manner,

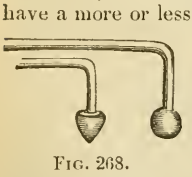


Fig. 268.

the parts being circumscribed by a piece of adhesive plaster, through an opening in which the application is made. Strong sulphuric acid also makes an issue of the proper depth, its effect being controlled by an alkali. The subsequent dressings are poultices. The moxa is a combustible substance, burned upon the surface; it may be composed of lint, carded cotton, hemp, agaric, etc., or the lint may be saturated with the nitrate of potassa. The substance selected should be firmly rolled into a pyramidal form, and held together by threads, or a solution of gum arabic, an inch or an inch and a half long, and of a diameter at the base corresponding with the size of the proposed eschar. Local anæsthesia being produced, the moxa is held in position with forceps or wire, and is ignited at the top; as it burns down, any desired degree of irritation can be obtained, from a simple redness to a deep eschar, according to the time it is maintained in contact with the skin.

7. **Hypodermic injection** is a method of inserting remedies into the subcutaneous areolar tissue. Its advantages are, rapidity of action; intensity of effects; economy of material; certainty of action; facility of introduction in certain cases; with some drugs the avoidance of unpleasant symptoms.[1] The apparatus required is a hypodermic syringe, needles, and solutions.

The syringe consists of a barrel and rod, and a canula of silver or steel, which has a point for penetration and an opening for injection of the liquid (Fig. 269); *a*, *b*, *c*, is a form with a glass tube, a graduated rod, and detachable points of two shapes; *d*, *e*, is a form of hypodermic syringe to be carried in a pocket-case: the point, inclosing the wire-cleaner, fits into a hollow graduated piston: the barrel is an ordinary silver tube, the size of No. 10 catheter, and is six inches long.

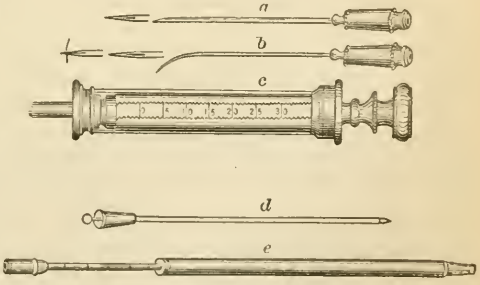


FIG. 269.

There are numerous cases, varying in size to suit the convenience of practitioners. To meet the increasing necessities of this form of medication the case[2] should contain a double fenestrated hypodermic syringe; three needles of different sizes, the smallest being the most delicate manufactured, the second larger, and the third of the ordinary size; extra leather washers and wires for keeping the tube open and clean; a small hone of the finest quality for sharpening the

[1] Com. on Hypodermic Method. [2] W. A. Greene.

points; a twenty-four minim glass measure perfectly exact; five two-drachm vials filled as follows: (1) sol. sulph. morphia, 16 grs. to the ounce, or ½ gr. to 15 m.; (2) sol. sulph. morphia, 8 grs. to the ounce, for children, or delicate females; (3) sol. atropine, 1 gr. to the ounce; (4) strong alcohol for cleaning the points; (5) fluid ext. ergot. The case may contain other solutions, a thermometer, and thumb lancet. It is not necessary to confine the injection to the painful part, and thus a tendency to abscess from repeated injection may be avoided.[1] As a rule, the least pain and irritation is caused when the injection is made at or near the insertion of the deltoid, or in front, between the ribs and hip bone, or from near the spine to the median line. Operate thus: On the first trial always use a minimum quantity of the drug;[2] draw the required amount into the syringe; elevate the point of the needle and force out a drop to expel the air; pinch up the skin at the point selected and thrust the needle into the subcutaneous connective tissue, avoiding any veins apparent; now gently force the fluid out drop by drop, watching its effects; if no effect is produced when the last drop is injected, withdraw the needle instantly and press the finger on the puncture for a moment; if faintness or other unusual symptom appear, withdraw the needle and apply such restoratives as may be required. (Fig. 270.)

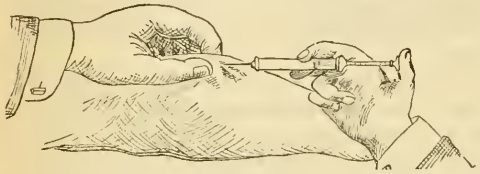


Fig. 270.

The needle[3] may be little larger than the proboscis of a fly, so delicate in fact that fluids as thin as water barely pass through it, and that quite slowly; it will penetrate the skin and reach the cellular tissue without pain, the little child and delicate female not being aware of its introduction in the cervical and lumbar spinal regions, or about the insertion of the deltoid. The needle should not screw on, but slide in, and thus avoid the wearing of the screw and the destruction of the thread. To keep the leather washer of the piston always damp, draw a few drops of water into the barrel after using it, and let it remain; when about to use the syringe, draw this water out, and the piston will work well. Prepare the solution of morphia sulph. by putting four grains in the vial and filling it with hot water; no acid is required to make and keep this a perfect solution; it is generally required in an emergency, and should always be in the case; it keeps indefinitely. To clean points draw the alcohol up and force it out of the tube several times; then detach the point and blow through the tube; finally, pass the wire through, wiping it every time it is withdrawn, after which leave the wire in the point.

8. **Vaccination** destroys or diminishes susceptibility to variola; every practitioner is under imperative obligation to exercise reason-

[1] C. Hunter. [2] F. E. Anstie. [3] W. A. Greene.

able care and diligence in the protection by this means of all persons subject to his professional advice and care.[1] It may safely be performed at any period of life, and no age should exempt a person from vaccination who has been exposed to small-pox: the most suitable period is six weeks from birth, and it should not be delayed beyond the third month, unless conditions unfavorable are unavoidably present, as acute febrile diseases or vesicular eruptions.[1]

The practitioner is responsible for the purity of the lymph which he uses, for pure virus can cause no other disease than variola; diseases are invaccinated only when the lymph is contaminated with blood, pus, or other carriers of contagia.[2]

Lymph is of two kinds, human or bovine, accordingly as it is taken from man or animal. Humanized virus must be selected from children of healthy parentage, and free from all hereditary taint, and cutaneous or other discoverable affections. In the collection of lymph, the following rules should be observed[3]: —

The vesicles should be perfect, having passed through all the stages without complications. Lymph must be taken from the vesicle before the areola has formed, the most favorable period being the eighth day, or day week after vaccination. Several fine punctures should be made in the top of the vesicle, when the lymph will exude from the cells and may be taken for immediate use, or for preservation. The vesicle should never be squeezed to obtain more lymph, but the surface may be gently wiped with a wet cloth to remove any obstruction of the puncture. If any blood appear it must be allowed to coagulate, and then be removed, before lymph is again taken. The virus may be taken on points, pieces of ivory, or quill scraped smoothly, two coats being applied; or in capillary glass tubes into which the lymph is drawn by capillary attraction, and which are then sealed at both ends by the flame of a candle, to the exclusion of the air. The lymph is frequently preserved in the scab, or crust, which is the dried vesicle. This falls between the twentieth and twenty-fifth days, is of a mahogany or amber color, and semi-transparent. If there is pus or blood in the scab, that portion, or the whole, should be rejected. The virus, in whatever form, must be preserved from the air, and in a cool place.

Vaccination may be successfully performed on any part of the body; but for convenience and freedom from irritation, the arm near the insertion of the deltoid muscle is ordinarily selected. The left arm is preferred to the right, in first vaccination, as it is not so much used. Though the operation is extremely simple, it requires great care and delicacy in its performance. A variety of instruments have been used, but a common lancet, slightly dull, answers every indication. It should be kept in a state of perfect cleanliness, as rust or filth are liable to poison the wound. After each vaccination it should be cleaned with a wet cloth. The operator should grasp the arm so as to make the skin tense at the point of insertion of the virus, and either make several punctures with the point of the lan-

[1] E. C. Seaton. [2] J. Simon. [3] J. B. Taylor.

cet, thus ||, or several incisions (Fig. 271), thus ||||, or abrasions, thus ###. The lancet should penetrate sufficiently to cause the appearance of blood. If the virus is taken from another arm, the point of the lancet should be charged by uncapping cautiously one of the cells of the vesicle. If the quill is used, first wet the charged extremity with a drop of water. If the scab is used, dissolve a small portion in a drop of water or glycerine on a piece of glass, and charge the point of the lancet. Whatever form of virus is used, be careful to rub the lymph well into the abrasions; the flow of blood, though considerable, does not interfere with the success of the operation.

Fig. 271.

The following facts[1] in regard to the progress of successful vaccination, and the complications which may arise, are important: After the inoculation, a period of inaction, comprising three or four days, is followed by a papule-like elevation of the skin, due to swelling of the cells of the deep layers of the epidermis, accompanied by hyperæmia; these cells continue to enlarge, and, by the fifth or sixth day, the pock is found augmented in size, and, from increased distention of the cells, presents the appearance of a vesicle, with a central depression, and is multilocular in structure. The contained fluid (*vaccine lymph*) is a colorless, adhesive liquid, containing leucocytes and minute granules, in which latter resides its virulent property. The papillary layer of the derma is now invaded by the morbid process; the free ends of the papillæ become strangulated by cell-impaction, and, melting down, mingle with the fluid contents of the pock. Occasionally, the disease extends completely through the derma, and involves the subjacent cellular tissue, which then shares the fate of the destroyed papillæ. On the eighth day (inclusive) the pock has, if it have been produced by long-humanized virus, acquired its greatest size; if it have been produced by bovine virus, or by humanized virus of early removes, it continues to increase in size for several days longer. On the ninth day the pock has increased in plumpness, its central depression is more marked, a brown incrustation has begun at the centre, the fluid contents are more decidedly purulent, and the whole is surrounded by a sharply-defined, bright redness of the skin, extending over a disk of from one to two inches in radius, and technically called the *areola*. In the human subject the areola is usually accompanied by febrile reaction; but in the calf there is no areola, and but little, if any, constitutional reaction. The further progress of the disease consists in the gradual fading of the areola, with the transformation of the entire pock into a hard, dry, translucent brown crust, which separates some time between the fifteenth and the thirty-second days, leaving a more or less depressed cicatrix, which is usually permanent, and which shows numerous lesser depressions, which give it the appearance termed foveolation. If the individual have previously had the disease, it usually runs a more rapid and less regular course, although the inflammation is apt to be more marked. Vaccinia usually runs its course without complications, and does not call for treatment. Excessive erythema is best treated by the application of a liniment composed of ℥ij of ung. stramonii, ʒj of liq. plumb. subacetat., and ʒviij of linseed-oil. True erysipelas is very rarely caused by vaccination, and does not require a modified treatment. Axillary

[1] F. R. Foster.

adenitis is common, and should be treated on general principles. The same is true of cellulitis. Ulceration of the pock (generally caused by violence) may be treated by sprinkling with equal parts of powdered starch and oxide of zinc, and the same may be used to check an immoderate flow of lymph, after opening the pock for the purpose of obtaining virus. The conveyance of syphilis in vaccination may be certainly prevented by complying with all of the following rules: (1) Use only bovine virus, or humanized virus which is known to be free from syphilitic virus; (2) after once applying the lancet, or other instrument, to the vaccinee, it should on no account be again applied to the vaccinifer, or any other person, until it has been thoroughly cleansed; (3) after once using a quill slip, throw it away. Vaccination generally confers complete and lasting protection against small-pox; any person may, however, constitute an exception. Hence, every individual should be revaccinated as often as once in five years, and whenever small-pox is present as an epidemic, or upon setting out on a voyage, or when about to undertake military duty. As a rule, revaccination succeeds. It should be carefully done, and repeated if unsuccessful.

9. **Transplantation of skin** is frequently required to repair defects either congenital or due to injuries and diseases which cause destruction of integument. These operations are chiefly confined to the face and joints, and have for their special and ultimate object the relief of the disfigurements, and the restoration of function of the parts involved, as of the mouth, or nose, or eye. Innumerable special operations have been planned and executed to meet the ever-varying indications which these deformities present; but there are certain underlying principles which should always govern the procedure, whatever method may be adopted. The object [1] in all cases is to obtain union by first intention, and to effect this purpose, (1) the flap must be of such ample size that subsequent shrinking will not interfere with the perfection of the cure; (2) there must be no effusion of blood forming a clot under the flap; (3) the margins of the flap must be held accurately together with the smallest amount of irritation. The more important features of the operation are as follows: [2] (1) in the choice of skin, select that which is normal and in healthy condition; dispose the patch of skin to be transferred so that its long axis corresponds to the direction in which the arterial vessels are distributed, and the free extremity of the patch towards their destination; (2) to secure precision in adapting a patch of skin to a new locality to which it is to be transferred, first prepare the space to be filled by paring its edges and dissecting them up sufficiently from their underlying connections to allow of their eversion; cut from oiled silk an exact pattern of the space and apply it to the surface which is to supply the new material; insert small pins at intervals around the pattern, at a distance of one line from the margin, as an allowance for shrinkage, but a larger allowance must be made for the length, so as to permit the patch to be brought around edge-

[1] T. Holmes. [2] G. Buck.

wise without strain. The methods of transfer of the skin are as follows: (1) By approximation; when the skin is supple and movable on both sides of the space, pare the opposite edges, dissect up the adjacent skin to a sufficient distance to permit their meeting and being secured by sutures; if there is too much strain, make incisions through the skin parallel with the wound; (2) by sliding; if upon one side only the skin is sound, prepare the space, and dissect up a patch of the required size in the healthy skin; glide this patch edgewise over the space, and attach its edges by sutures; (3) by

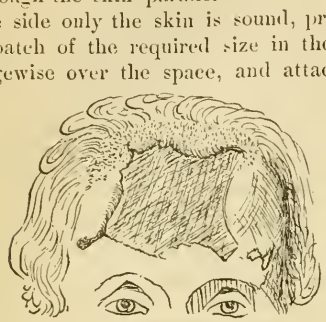


FIG. 272.[1]

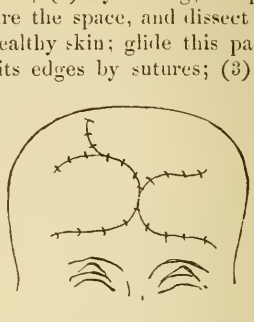


FIG. 273.[1]

transfer to a distance; this is done either by transferring the patch edgewise, but making its pedicle describe a part or the whole of a semicircle; or by jumping over intervening tissue, and severing the pedicle when union has taken place. The raw surface left after transfer of a patch should first be covered with scraped lint, and then with lint saturated with collodion; a crust forms which only separates to leave a healthy granulating surface. The suture used may be (1) the interrupted thread; the needle should be trocar-pointed; the glove-makers' thread answers as well as wire; insert the needle obliquely from the edge backward so that the suture will have a tendency to evert the edges of the wound; insert sutures enough to secure exact coaptation, for multiplicity is not objectionable; (2) the common figure-of-eight; (3) the beaded wire clamp as an auxiliary for the support of other sutures.[2]

In many instances these several sutures may be required in different parts of the same flap or flaps, depending upon the degree of tension of the parts. The beaded wire clamp, however, when the tissues are in suitable condition, is more available than the others, being easily applied, and very powerful in retaining the flaps in exact apposition.

This consists of silver wire with a glass bead on the extremity, held in place by a disk of leather; the wire being drawn through the two sides at the desired point, another bead is slipped down and pressed firmly against the wound, while the wire is fastened by twisting the end round a piece of wood; this

[1] M. Serre. [2] G. Buck.

suture may remain for six to ten days, and if immediate union fail, they still retain the parts in good position for union by granulation.

Losses of integument from the forehead may be supplied by the neighboring skin, as follows (Figs. 272, 273): The margin and the space itself being well freshened, dissect up on either side flaps which may be glided to such an extent as to meet the flaps on the opposite side without tension. The form of these flaps must depend upon the shape of the surface to be covered, and can be governed by no fixed rules. Restoration of the lower eye-lid is effected by the removal of a V-shaped flap and the formation of a quadrangular patch from the cheek (Fig. 274). Illustrations of the methods of restoration of other parts, as the lips, nose, penis, will be found in connection with those subjects.

Fig. 274.

10. **Cicatricial contractions**[1] follow all wounds with extensive loss of skin, and as this is generally greatest after burns, cicatrices from this cause usually contract most; it results from the disposition of the inflammatory new formation in the wound to give off water as the original gelatinous tissue by degrees atrophies to dry connective tissue. Operations should not be undertaken for the relief of cicatricial contractions until every proper effort has been made to overcome them; for in the course of months or years the vessels are obliterated, and the structure becomes more like that of subcutaneous tissue, being less rigid, more distensible, tougher, more elastic; hence mobility increases with time. This atrophy of the cicatrix may be aided by compression and distention, long and persistently applied. When these measures have accomplished all that can be reasonably expected, some one of the many methods practiced may be adopted. In general, the entire cicatrix should, if possible, be removed, and its place supplied with new skin. This may be effected when the cicatrix is narrow and linear (Fig. 275), as follows:[2] Dissect out the cicatricial tissue cleanly; now make incisions on either side of the wound, parallel to its borders, and two, three, or more inches from them, through the subcutaneous tissue; loosen these strips sufficiently to permit of their accurate approximation; unite them by suture and allow the lateral spaces to heal by granulation (Fig. 276). In many cases the distorted parts may be liberated by detaching them from their underlying

Fig. 275.

[1] T. Billroth. [2] T. D. Mütter.

connections sufficiently to allow them to be restored to their normal relations, and then transplanting sound skin from the nearest available locality with which to fill up the space made bare by the restoration.[1] Finally, the corded folds that maintain the contraction may be excised and the edges of the wound divided at every point where any resistance still remains which prevents complete extension of the part, or even dissecting up the edges from their underlying connections, the purpose being to give the utmost freedom of motion; the second step is by mechanical appliances to maintain parts in their restored position until cicatrization is complete, and for a longer period if necessary; the third factor in the cure is to regulate the process of cicatrization so as to keep a smooth and even surface, by repression of the granulations with caustics thoroughly applied, and by adhesive, or better, rubber plaster, applied firmly and so as to overlap each other; if contracting bands form they must be divided; cicatrization may be aided by leaving islets of cicatricial skin on the wound or by transplanting skin to the part.[1]

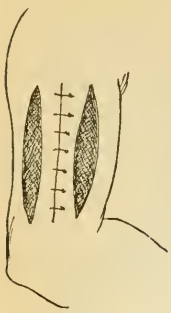


Fig. 276.

The selection of any one method must depend upon the situation and condition of the particular cicatrix. In the flexure of joints, simple subcutaneous division of the bands at many points, combined with extension by instruments, will frequently prove successful; where the cicatrix is broad, flat, and dense, transplantation of skin must be practiced; if the lip is destroyed, it may be reconstructed by a series of operations (p. 344, et seq.); if the lower eyelid is injured, the cicatrix may be replaced by the healthy skin of the cheek (Fig. 274); if the lower jaw is depressed and fixed, the cicatrix may vary in extent and firmness so much as to require a judicious selection of one or more methods in any individual case. The following operation on a cicatrix of the neck illustrates a combination of methods: —

Fig. 277.

This cicatrix generally consists (Fig. 277) of a broad, dense structure, extending from the lower border of the under jaw to the top of the sternum and clavicles, and preventing the elevation of the jaw; the saliva escapes from the mouth, and the tongue is exposed to view. Operate as follows:[1] first, divide the entire cicatricial band into three serrated angular flaps, by two diverging incisions carried from the symphisis menti downward and outward to either lateral margin

[1] G. Buck.

of the band where it joins the clavicles; from these terminal points make incisions, one along either margin of the band upwards and outwards to the lower edge of the jaw; dissect up these three flaps from the connective tissue, beginning at their apices, and proceeding toward and slightly beyond their bases; the head is thus relieved and can be moved in every direction; readjust the detached flaps to the denuded surface while the head is kept in an elevated position; excise redundant folds and pare off the edges of the flaps, if necessary, to adapt them to each other; incision may be made along the base of the neck to relieve tension; in the subsequent treatment the chin must be maintained elevated by apparatus, as a stock, or a chin-support attached to a spiral brace; if at any time the granulations become exuberant they are reduced by applying the solid nitrate of silver and pressing it firmly into them, or by the caustic potassa; if new cicatricial bands form they are divided at two or more points, and entirely through their thickness. The result is, in ordinary cases, complete relief from the effects of the cicatrix.

The obliteration of depressed cicatrices after glandular abscesses and exfoliation of bone has been effected by the following operation:[1] Subcutaneously divide all of the deep adhesions of the cicatrix with the tenotomy knife introduced a little beyond its margin and carried down its base; carefully and thoroughly evert the depressed cicatrix, turning it inside out so that the cicatricial tissue remains permanently raised; pass two hare-lip pins, or finer needles, through the base, at right angles to each other (Fig. 278), so as to maintain the cicatrix in its everted and raised form for three days; remove the needles and allow the cicatricial tissue to fall to the level of the surrounding integument.

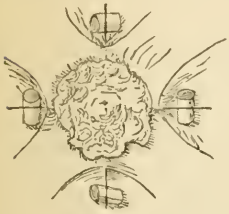


Fig. 278.

Cicatrices predispose to the development of false keloid growths, which belong to the sarcomatous series; these tumors rather replace a scar, than grow out of one; in the regular course of development of a scar, the presence of round-cell and spindle-cell tissue is only provisional, as they speedily give place to fibroid tissue; but either one of these elements may persist longer than its proper time, and if it accumulates in disproportionate amount, a sarcomatous tumor is produced instead of a scar.[2] They appear as nodular hypertrophies of the cicatrix, of a dusky or bluish color. They may give rise to no symptoms, and finally disappear, or they may become very sensitive and painful, with intolerable itching. No treatment is required, unless the growth is very troublesome. The most efficient remedies are blisters; these may be followed by friction, with mercurial ointment and extract of belladonna. If no relief is obtained, excision of the cicatrix must be performed, to be repeated if the growth returns.

[1] W. Adams. [2] E. Rindfleisch.

VII.

THE DIGESTIVE ORGANS.

CHAPTER XXX.

THE LIPS.

I. WOUNDS.

The lips are covered externally by skin, internally by mucous membrane, and contain fat, glands, and muscle.

1. **Wounds of the lips** gape widely, and can be retained in perfect apposition only by suture. If the wound is partial, the silk or wire suture, with adhesive strip, will suffice; but if the entire lip is divided the hare-lip pin should be used (Fig. 279). If there is hæmorrhage, apply torsion to the artery, or pass the suture-pin through it; remove the suture on the third or fourth day.

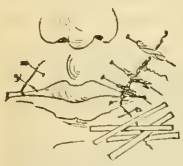


Fig. 279.

II. CONGENITAL DEFECTS.

Hare-lip is a congenital non-union of the central, or of the central with the lateral portion of the upper lip, the cleft corresponding with the junction of the intermaxillary, or of the maxillary and intermaxillary bones;[1] it is most common in males and is frequently hereditary;[2] it may be single, double, or complicated.

The fissure[3] may appear as a short notch, but in general it extends to within a little of the nostril, and is often continuous with it; when double it may be of the same size on each side, or there may be a short notch on one side and an extensive one on the other; the substance of the lip always varies much in such cases, being thick and fleshy in some and in others thin and defective in all respects, and the breadth of the gap usually varies in accordance with these characters. There is always, even in the worst cases of double cleft, an intermediate portion of lip which may be broad or narrow, long or short, thin or of the natural thickness of the lip, but generally it is deficient.

[1] W. Froelik. [2] C. Forster. [3] Sir W. Fergusson.

The general rules of treatment are: (1) If the infant is feeble, delay operation until after the third month; (2) if healthy, and the cleft single, operate, if it is desired, immediately;[1] if there is no special urgency, delay till from the third month to the sixth month;[2] the comparative mortality in the different periods favors the latter course;[3] (3) when there is inability to take food, operate at the earliest moment; (4) defer the operation, if diarrhœa or eruptive diseases are present during first dentition, and in midsummer months;[4] (5) if the hare-lip is double, wait until the child is two or three years old,[2] unless the conditions render an earlier operation necessary; (6) chloroform is not necessary in infants. The stages of the operation are: (1) the infant, having a sheet wrapped around its body so as to inclose its arms, should be held upright in the arms of an experienced assistant, and its head firmly grasped by a second assistant (Fig. 280); the older child should recline with its head raised; (2) separate thoroughly all adhesions to the gums so that the two flaps move freely; (3) make section of the edges of the cleft with strong scissors (Fig. 281) or with the knife (Fig. 282), and in such form as will most completely obliterate deformity when the flaps are placed in perfect apposition; (4) close the wound with hare-lip pins if the tension is great (Fig. 283), and with silver wire suture if it is but slight; introduce the suture so deeply as to reach, but not to penetrate, the mucous membrane; (5) support the flaps with long adhesive strips, or with a well-adapted truss (Fig. 284).

Fig. 280.

Fig. 281.

Fig. 282.

Fig. 283.

1. **Single hare-lip** may occur on either side and may vary in extent from a slight indentation to a complete division into the nostril. The two sides of the cleft differ in their regularity, being on different levels, and variously beveled at the angles. If the knife is used, enter it at the angle and cut away a sufficient portion to make the margin straight, and secure easy and perfect adjustment; at the free border (Fig. 285) turn the edge inward to the cleft and save a portion of the mucous membrane to avoid the notch in the lip. If the scissors are preferred, the same section can be made. If the free borders are irregular and round, the method of saving

Fig. 284.

Fig. 285.

[1] Sir W. Fergusson. [2] S. D. Gross. [3] T. Bryant. [4] F. H. Hamilton.

the parings[1] should be adopted, namely, make an incision from 1 to 2 (Fig. 286), through the thickness of the lip to the free margin, which should not be divided; on the other side transfix the lip at 3 and separate a flap as far as 4, dividing it at 5; bring the two sides together and attach the flap 5, 3, to 1, by a suture, and the flap, 5, 4, to 2; apply two intermediate sutures, and the result will be a lip nearly double in depth of that obtained by the ordinary method (Fig. 287); the same result follows if the two portions, pared off the sides of the cleft, remain attached to each other (Fig. 288), as well as to the free edge of the lip, and are turned downwards and the two sides are united as before.[2] This method is peculiarly appropriate to clefts which do not extend through the whole depth of the lip, but terminate at some distance from the nostril.[3]

Fig. 286.

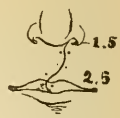


Fig. 287.

Fig. 288.

In cases of very extensive cleft, or with a projection of one portion of the jaw, the following operation is advised:[3] Cut flaps on either side (Fig. 289) and leave them attached, on one by the lower, and on the other by the upper end, the incision being carried around the nose as far may be deemed necessary; the flap attached by its lower end is then turned downwards so that its red edge forms the border of the lip, while the other is drawn upwards towards the nostril, and they are thus dovetailed together (Fig. 290) with interrupted sutures.[4]

Fig. 289.

Fig. 290.

In some cases the continuity of the lip border may best be preserved by the following method:[5] Remove the edge of one of the borders clearly throughout; on the other cut a flap (Fig. 291) with its pedicle below; bring the edges together so that the flap is applied from below upwards upon the notch. If the flaps in any case do not promptly unite and the edges continue to granulate, they should be maintained in apposition for the purpose of securing union by granulation.[6]

Fig. 291.

Fig. 292.

2. **Double hare-lip** may exist with or without defect in the bone. When complicated with fissure of the hard palate, the best conducted operations are very liable to fail.[7] If the clefts are limited to the

[1] M. H. Collis. [2] M. Clémot; J. F. Malgaigne. [3] T. Holmes.
[4] Giraldès. [5] Mirault. [6] Sir J. Paget. [7] M. Guersant.

lips (Fig. 293), and there is not severe tension, operate upon both sides at the same time (Fig. 294); but if the traction upon the parts is great, operate upon one side at a time, making a central flap which can be attached at the sides and to the angles of the flaps (Fig. 294).

Fig. 293.

Fig. 294.

If the intermaxillary bone has not formed ossific union, it projects more or less, according to its attachments to the septum nasi. Except when it is a mere pendulous mass from the tip of the nose, efforts should be made to save it, both because it contains the sacs of the incisor teeth, and its presence is necessary to maintain the form of the upper jaw and lip.[1] In the slighter cases of projection of the intermaxillary bone it is merely necessary to fracture its attachment to the septum, and press the mass back into position, or if it be too large to fit the gap, the exuberant parts must be pared away at the sides, the adjacent sides of the superior maxillary bones refreshed, and any teeth projecting across the cleft removed.[1]

A wedge-shaped piece may be cut from the septum,[2] which allows the mass to recede more readily into the cleft (Fig. 295); a suture may be applied to the sides of this notch to retain the depressed bone in place.[3] The bone has been retained in position by silver sutures passed through it and the adjoining hard palate,[4] but three teeth were destroyed by the penetration of their sacs. The bone has been successfully held in position by at once uniting the clefts in the soft tissues.[1] When the flaps are insufficient to close the cleft, they may be dissected away from the cheek to such an extent as to admit of their easy approximation. If the process is tedious it should be divided into stages, dealing first with the projecting intermaxillary bone, and then with the soft parts.[1] When the mass is suspended from the tip of the nose (Fig. 296), it must be removed by careful dissection with strong scissors, the soft parts being retained and so placed as to form a columna nasi, or to fill the gap in the lip (Fig. 297).

Fig. 295.

Fig. 296.

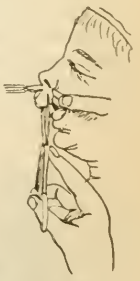


Fig. 297.

III. HYPERTROPHY.

Hypertrophy of the mucous glands is characterized by two elevated pendulous portions of tissue appearing on either side of the

[1] T. Holmes. [2] G. Blandin. [3] Bruns. [4] Von Langenbeck.

middle line (Fig. 298), and is due to an increase of the glands of the part and not of the mucous membrane. Make a straight or elliptical incision in the line of the lip; excise the submucous tissue; close the incision with fine sutures.[1]

Fig. 298.

2. **Hypertrophy of the lip** generally occurs in scrofulous subjects, and consists in chronic thickening of the deep structures. It may result from a congenital enlargement of the capillaries constituting a nævus (Fig. 299),[2] and then has a raspberry discoloration, is flabby, pendulous, and contains hard knots in its substance. Operate as follows:[2] Remove a V-shaped patch, equidistant from the angles of the mouth, and having its apex low down in the median line under the chin; divide the mucous membrane along the line of its reflection from the jaw on either side of the wound; bring the opposite edges of the wound together and secure them in exact co-aptation by pin-sutures inserted at equal distances from each other below the lip-border; between every two pin-sutures add a silver wire, and on the vermilion border, fine thread sutures, one being on its buccal surface; when union is complete, a second operation is required to reduce the thickness of the lip. This is effected by two parallel incisions, including one third of the thickness of the lip and penetrating deeply into its substance; the resulting wound, well secured, rapidly heals and reduces the lip to the normal size. The raspberry color must be destroyed by the actual cautery.

Fig. 299.

IV. ACQUIRED DEFECTS.

1. **Reconstruction of the lips** after losses from injuries or diseases has now been reduced to very exact methods, and the results which have been obtained are in the highest degree creditable to the author.[2] The following examples illustrate the principles which should guide in planning and executing these perplexing operations, and the details of their performance: —

1. **The lower lip**[2] is reconstructed as follows: first remove the diseased portion. This may be done by the V-shaped or quadrilateral flap. The V-shaped flap is made as follows: make an incision commencing at a point within half an inch of the angle of the mouth on both sides, and dividing the lip border, carried downward on either side of the morbid growth in converging lines, till both incisions meet under the chin in the median plane; this flap should be dissected up from the periosteum and removed; next divide the lining mucous membrane

[1] T. Bryant. [2] G. Buck.

of the mouth on both sides of the wound, along the line of its reflection from the jaw to the inside of the lip, and continue it outward as far as is necessary to permit the edges of the V-shaped wound to meet at the symphisis and be secured by sutures. After the parts have healed, the mouth is restored by the following operation (Fig. 300): first designate the incisions by points, as at *a*, *b*, and *c*, *b*; then with the forefinger of the left hand placed on the inside of the mouth, transfix the lip at *a*, on the right side and carry an incision through the entire cheek upwards and outwards an inch and a half to *b*, near the middle of the cheek; next transfix the lip at c, and carry the incision outward to join *b*; then make an incision from the starting point *a*, vertically downward to the edge of the jaw *d*, and to the periosteum; by retracting this incision a V-shaped space is made for the lodgment of the triangular flap, *a*, *b*, *c*, and a new and naturally-shaped angle is formed for the mouth at the point *c*; the same procedure is required on the opposite side (Fig. 300) at the same or a subsequent sitting; the result (Fig. 301) is a newly-formed mouth with good angles.

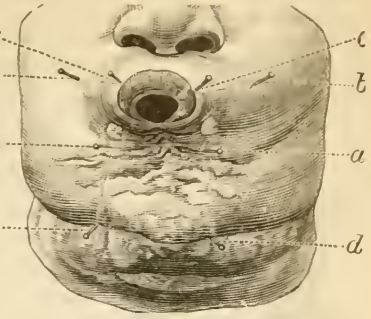


FIG. 300

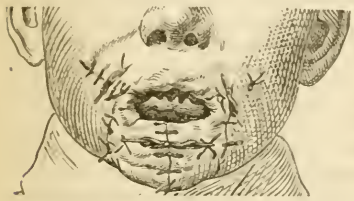


FIG. 301.

The quadrilateral flap is made when a large section is removed (Fig. 302).[1] Make incisions, *a* to *b*, commencing at a point within less than half an inch of each angle of the mouth, vertically downwards till they join a transverse incision *b*, *b*, crossing the lower part of the chin; dissect this flap from the periosteum; now continue the transverse incision outwards on both cheeks to a point within a fingers' breadth of the angles of the jaw and thence upwards a distance of two inches in a line curving slightly forwards, *b c* and *b c*; dissect up these cheek flaps on both sides, and divide the mucous membrane alone, along the anterior margin of the masseter muscle upwards, and thence forwards to the upper canine teeth; the two cheek flaps thus formed

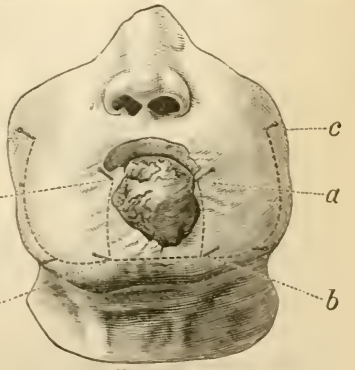


FIG. 302.

[1] G. Buck.

must be glided forwards edgewise towards each other and made to meet over the symphisis menti, where they are secured in accurate coaptation by three pin-sutures and intermediate fine thread sutures; close the spaces left bare by approximating the apposite edges and securing them by sutures; the facial arteries are necessarily cut and must be promptly ligated. The result of this operation is a circular and pouting shape of the mouth (Fig. 300). A second operation is required to remedy this defect: Make an incision on each side, through the cheek from *a* to *b*, another from *c* to *b*, and a third vertically from *a* to *d*, as already described (Fig. 300), and adjust the flaps as directed. The result of the last operation is a well-formed mouth.

2. **The lower lip destroyed by a shell wound** was restored as follows[1] (Fig. 303): Two incisions were made dividing the under lip, one from *d*, and the other from *b*, converging to *c*, under the chin; this V-shaped flap was removed, including a notch upon the lip border, and the adherent portion; the remaining left half of the lip and the adjacent cheek were detached from the jaw as low down as its inferior border, and as far back as the last molar tooth; this dissection permitted the parts to glide towards the right side and in part fill the chasm left by the removal of the V-flap.

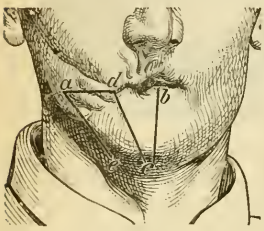


Fig. 303.

The next step was to make a quadrilateral flap by the incisions *d* to *a*, and *a* to *e*, which was glided forward edgewise till it met the left half of the under lip to which it was attached; new lip border was constructed on the upper edge of the transferred cheek-patch by excising a prism-shaped strip of tissue from between the skin and mucous membrane. The mouth was also lengthened on the right side, and a border made as just described; a new angle was also made by securing the opposite edges of the divided cheek together at a point where the newly constructed upper and lower lip borders terminated; the space in the right cheek was filled by extending the tranverse incision, loosening the skin and gliding it forward. At a second operation the left angle of the mouth was extended by the method given (Fig. 300), and the result was satisfactory (Fig. 301).

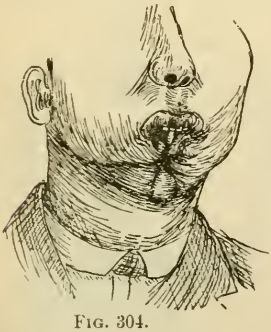


Fig. 304.

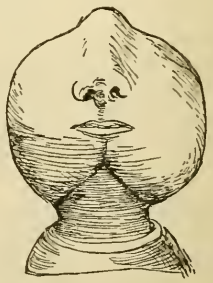


Fig. 305.

3. **The lower lip and chin** destroyed by gunshot (Fig. 304) have been reconstructed by a similar operation.[2] The lower jaw was carried away from

[1] G. Buck.

[2] J. W. S. Gouley.

the second bicuspid tooth on the left, to the second molar tooth on the right. The incisions, commencing at the margin of the cicatrix, in the cleft of the lip, extended on either side to the angles of the jaw, and thence upwards to *c* (Fig. 302) until both flaps became, on loosening their deep attachments, so free as to meet readily in the median line. A useful lip resulted (Fig. 305).

4. **The right half of both lips** was restored as follows:[1] The right cheek was detached from the jaws above and below, and the dissection continued in every direction till the jaws could be separated far enough to admit the thumb edgewise between the front teeth; the thinned cicatricial edge of the right cheek, bordering on the region of the angle of the mouth, was pared afresh for adjustment to the new lip; both lips were now detached from their connections, the upper by an incision from the ala nasi to the middle of the left cheek; the lower by an incision across the middle of the chin parallel with and as far into the left cheek as the former; this bifurcated quadrilateral flap was advanced towards the right side of the face, and its two extremities adjusted with the lip borders in contact with each other, by pin and thread sutures; the result was a contracted mouth drawn to the right side. This defect was remedied as previously described (Fig. 300), and the mouth assumed symmetrical proportions.

5. **The upper lip and adjacent portion of the cheek** may be reconstructed by material taken from the under lip[1] (Fig. 306), as follows: (1.) Divide the extremity of the upper lip where it joins the right cheek, through its entire thickness, at right angles to its border, to the extent of one inch from the border, *a* to *b*; make a second incision from *b* to *c*, one and a half inches long, parallel to the border of the lip; fold this quadrilateral flap edgewise upon itself and to enable it to meet, and be adjusted to, the remaining half of the upper lip; divide its base obliquely half across, *c* to *d*; liberate the left half of the upper lip by incising the buccal mucous membrane along the line of its reflection from the jaw to the lip and cheek, and detaching the parts towards the orbit from the underlying periosteum on the right side; pare a strip of vermilion border from the extremity of the half lip of such length as will permit it to be matched to the free extremity of the under-lip flap; unite the two flaps in a vertical line by sutures, and close the space between the newly-adjusted half of the mouth and the neighboring cheek by approximating the opposite parts. The result, when the healing is complete, is a circular and pouting mouth. (Fig. 307.)

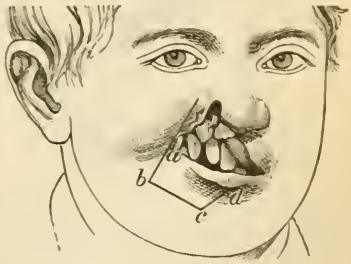


FIG. 306.

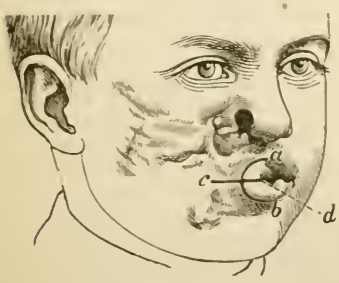


FIG. 307.

6. **The angle of the lips** is restored, as follows[1] (Fig. 307): Make an incision along the line of the vermilion

[1] G. Buck.

border, circumscribing the circular half of the mouth and extending to an equal distance on the upper and lower lips, *a* to *b*, dividing only the skin; now insert a double-edged knife at the middle of this curved incision and direct it flatwise towards the cheek between the skin and mucous membrane, so as to separate them from each other as far as the new angle of the mouth is to be extended; divide the skin with strong scissors on a line with the commissure of the mouth outwards towards the cheek, *d* to *c*; now divide the mucous membrane on the same line, but not so far outward as the incision of the skin, and attach the angle at the terminus of the incision of the mucous membrane to the corresponding angle of the skin by a single thread suture; the fresh-cut edges of skin and mucous membrane above and below that are to form the new lip borders are to be shaped by paring so that the mucous membrane shall overlap the skin after they have been secured by fine-thread sutures inserted close together.

7. **The right half of the upper lip** is reconstructed thus: after the loss of portions of the cheek, the ala nasi, and the entire superior maxilla (Fig. 308); prepare the left half of the upper lip by incising the buccal mucous membrane along the line of its reflection from the upper jaw to the lip and cheek as far as the molar teeth; next divide the lip through its entire thickness from the point where it joins the ala nasi, on a line parallel with the lip border outwards to the middle of the cheek, *a* to *b*, and trim it square at its free extremity; prepare the redundant under lip so as to employ it for supplying the deficient right half of the upper lip according to the method described in Fig. 306, namely, by incisions from *c* to *d*, *d* to *e*, and *e* to *f* below (Fig. 308);

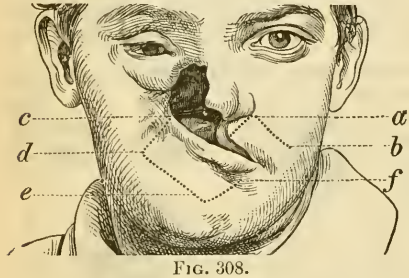


Fig. 308.

the open space in the right cheek resulting from the transposition of the parts is closed by making a transverse incision through the entire cheek on a line with the commissure of the mouth as far outward as the masseter muscle, and beyond it only through the skin; by dividing the buccal mucous membrane along the anterior edge of the masseter, above and below, the cheek may be brought forward and united to the under lip flap. The result of this operation (Fig. 309) required next the restoration of the right half of the mouth; this was effected by the incisions outlined, and as described in the reconstruction of the mouth (Fig. 307). Closure of the opening in the nose was effected by another operation.

Fig. 309.

[1] G. Buck.

8. **The upper lip and nose** is restored thus[1] (Fig. 310): An incision through the cheeks and lip, commencing at the median line, on a level with the floor of the nasal cavity, was carried outward and downward on both sides of the face in a curved line so as to circumscribe both angles of the mouth, and terminate at a point below the junction of the middle and outer third of the under lip, *a* to *b*, *a* to *c*; those flaps were brought toward each other edgewise, and their ends being pared and made straight, were adjusted to each other on a vertical line in the median plane, and secured by three pin sutures and intermediate thread sutures; the open space was closed by detaching the mucous membrane from the cheeks, which so far liberated it that the cheeks could be readily brought forward and attached to the flaps by pin and thread sutures. The parts healed, except at the point of union of the flaps, where sloughing occurred.

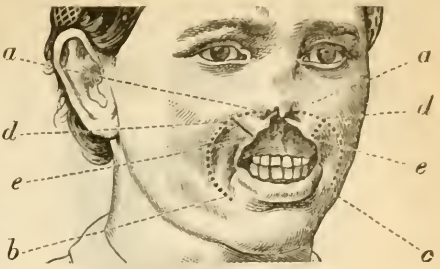


FIG. 310.

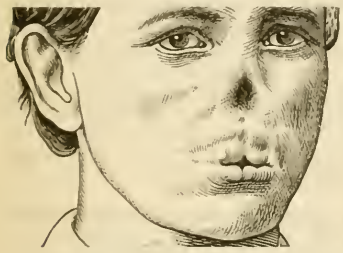


FIG. 311.

The second operation was designed to remove the obstruction of the nostrils by a vertical incision from a point midway between the eyebrows downward upon the nose to a point on a level with the floor of the nasal cavity, from which a transverse incision was made, one inch on either side; the flaps were dissected up, the parts blocking up the nostrils were cleared away, the skin parted to correspond to the bony margin of the new opening, and left to cicatrize, which followed in due time. A third operation to improve the upper lip was performed nearly the same as the first, namely, incisions on each side of the mouth, completely through the cheek, were made from a point about half a finger's breadth below the nasal orifice, to corresponding points on each side of the chin, and at a distance of an inch from the angles of the mouth, and the border of the under lip; these flaps were brought together in the median line, and, their ends being squared, they were adjusted by suture and the gap closed as before. The results (Fig. 311) were satisfactory. The fourth operation was designed to extend the angles of the mouth, and the operation was in detail as that given (Fig. 309). A fifth and sixth operation were performed to reconstruct the nose, the flap being cut from the forehead according to a pattern carefully prepared,

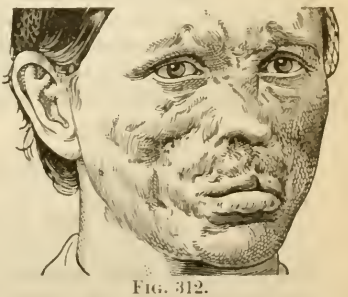


FIG. 312.

and turned down to its position. The final result of the several operations was entirely satisfactory (Fig. 312).

9. **The lips and the nose**, after the loss of the right half of the upper lip, the adjacent portion of the cheek, and right ala nasi, was restored as follows (Fig. 313):[1] The left half of the upper lip, being held upon the stretch, was detached from the jaw by an incision of the buccal mucous membrane, carried along the line of its reflection from the jaw to the lip and cheek, and extended outwards as far as the molar teeth, and upward on the level of the periosteum towards the orbit, thus enabling the lip and cheek to be glided over to the right side; a strip of the vermilion border, an inch in length, was pared away from the extremity of the half lip and left attached temporarily; material for the deficient half of the upper lip was obtained from the redundant right half of the under lip by the incision *a*, *b*, *c*, and according to the method given (Fig. 306); this quadrilateral flap was adjusted by its free extremity when brought around edgewise to the left half of the upper lip; the open space remaining in the cheek was closed by making another quadrilateral flap, *b*, *e*, *f*, *g*, which was slid forwards edgewise and attached to the transposed under lip flap; to cover the bare surface remaining, the incision, *e*, *f*, was prolonged to *h*, and the angle, *h*, *f*, *g*, was dissected up and drawn forwards, and adjusted with sutures.

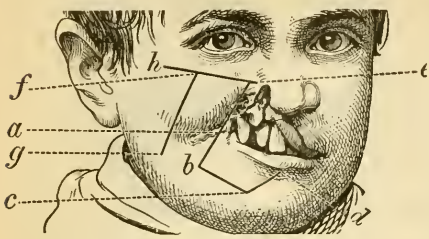


FIG. 313.

9. **The central portion of the upper lip** may be reconstructed by the following operation:[2] make two incisions, one on either side of the alæ nasi (Fig. 314), down to the centre of the lip, and then carry the united incisions vertically through the remaining part of the lip; dissect up these flaps from their lateral attachments until they move freely, and can be approximated readily in the median line, where they are united by pin sutures, the wire suture being used for the other edges.

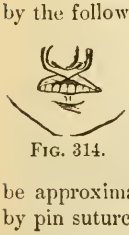


FIG. 314.

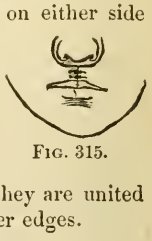


FIG. 315.

CHAPTER XXXI.

THE PALATE.

THE roof of the mouth consists of two portions, viz., the fore part, or hard, and the back part, or soft, palate; the former is covered by the periosteum and mucous membrane, which adhere intimately to-

[1] G. Buck. [2] Dieffenbach.

gether; the soft palate constitutes an incomplete and movable partition between the mouth and pharynx, continued from the posterior border of the hard palate obliquely downward and backwards; it incloses muscular fibres and numerous glands.[1]

The instruments required for operations on the hard and soft palate are as follows (Fig. 316): double-edged staphyloraphy knife, *a*; seizing forceps, *b*; adjuster for wire sutures, *c*;[2] tenaculum for pulling the velum aside, or holding the edges of the flaps, *d*; spiral needles for sutures, *e*;[3] curved scissors for dividing the muscles, *f*; knives for paring the edges, *g*;[3] periosteotome, *h*,[4] or *j*;[5] wire-twisting forceps, *i*;[2] an oral saw, *k*;[5] mouth gag (Fig. 317).[3]

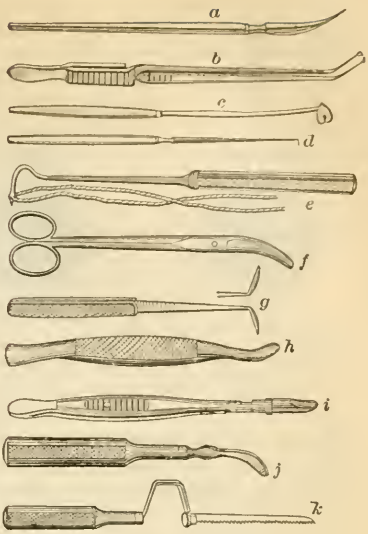


Fig. 316.

I. CONGENITAL DEFECTS.

Fissure or cleft of the palate, as a congenital defect, may involve: (1) only the uvula, 1 (Fig. 318); (2) the soft palate 2 (Fig. 318); (3) the hard palate as far forwards as the middle of the palate process of the superior maxillæ or through the palate bones only (Fig. 319); (4) the alveolar ridge entire with the cleft of the palate (Fig. 320); (5) cleft or notch of the alveolar ridge with entire cleft of palate; (6) double cleft of the alveolar ridge, with a fissure from each running backwards and inwards and joining behind the intermaxillary bone, becoming continuous with a median fissure.

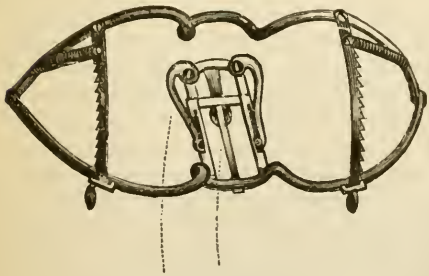


Fig. 317.

[1] Quain's Anatomy. [2] J. M. Sims. [3] W. R. Whitehead.
[4] L. A. Sayre. [5] D. H. Goodwillie.

There are also many grades of separation of the fissure. Usually the cleft in the palate is narrower in front and widens towards the velum, but in some the gap will be very wide and in others very narrow, though complete from alveolus to uvula. In partial clefts the breadth is often much greater than is apparent from its extent, in some instances giving the greatest breadth met with.[1]

FIG. 318.

FIG. 319.

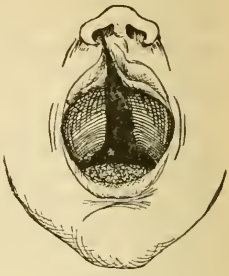


FIG. 320.

The operations undertaken for the relief of fissured palate are staphyloraphy, and uranoplasty, the former being an operation on the soft, and the latter on the hard palate.

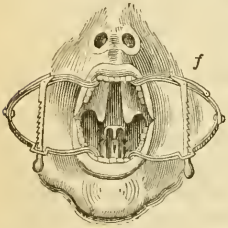


FIG. 321.

If the uvula alone is bifid and the voice unaffected, it is better not to interfere with the fissure. As the articulation, however, is generally affected, closure by suture is the rule of treatment;[1] the operation may be performed at any age, but it is better to defer it until the child is at least three or four years old,[2] or even until adult life,[3] when circumstances are unfavorable to an early operation. If the patient is a child, chloroform should be given and the gag inserted *f* (Fig. 321).[4]

1. **Staphyloraphy,** suture of the soft palate, is an operation which the surgeon need have no hesitation of undertaking when the cleft is limited.[1] Place the patient in a chair in a good light, first seize one point of the cleft with long spring forceps, draw it forwards, transfix it near its inner border with a narrow, sharp knife on a long handle, and freely cut upwards or downwards and remove the mucous membrane along the whole of its inner margin (Fig. 322); make the same section on the opposite side and insert two sutures.[1]

When the cleft extends forwards through the whole of the velum, or even to a slight extent into palate bones, the operation is more complicated, for every attempt to bring the edges of the fissure to-

[1] G. Pollock. [2] T. Holmes; G. Pollock; T. Bryant.
[3] Sir W. Fergusson; F. H. Hamilton. [4] W. R. Whitehead.

gether is opposed by the combined actions of the levator and tensor palati muscles, on either side, drawing directly away from the median line at which the edges of the fissure should meet; these muscles must therefore be divided to insure success.[1] The relaxation of the tissues of the fissured velum may generally be sufficiently secured by means of incisions made with strong curved scissors, so as to divide the posterior pillar of the palate just where it begins to spread out into the velum; in some cases an additional stroke or two of the scissors is necessary to divide a band of firm tissue extending above and behind the soft palate.[2] The division of the muscles is also effected as follows: pass a suture through one section of the soft palate at the root of the uvula, secure the ends by a knot, and have it held outside the mouth; repeat a similar suture on the opposite side; draw one of the sutures firmly, holding one half of the soft palate to its opposite side so as to stretch this section of the palate towards the median line; recognize the hamular process in the substance of the soft palate internal and a very little posterior to the last molar tooth: introduce the point of a thin, narrow knife fixed in a long handle, the blade down, a little in front and to the inner side of this process and carry it upwards, backwards, and somewhat inwards, until the point is seen in the gap, having passed through the entire thickness of the soft palate, and cut partially, if not wholly, the tendon of the tensor palati; raise the handle of the knife, depressing its point, and as the blade is drawn forward make it cut downwards so as to pass through a considerable section of a circle on the posterior surface of the palate, by which the division of the greater portion of the levator palati is effected; complete its section as the knife is withdrawn.

Fig. 322.

If the muscle is properly divided all movements of the palate cease, and it becomes pendulous and flaccid; if there be any further resistance, reintroduce the knife and divide the fibres more freely.[1] The divisions of the muscles may be made a day or two before the operation for closing the fissure and thus avoid the bleeding;[3] or the muscles may be divided after paring the edges, and inserting the sutures, the palate being put on the stretch by means of the threads held in the hand;[4] lateral incisions through the soft parts completely dividing the soft palate from its lateral attachments will allow the two halves to fall together.[5]

The edges of the fissure should now be thoroughly denuded of mucous membrane, and the sutures inserted.

[1] G. Pollock. [2] J. M. Warren. [3] G. W. Callender. [4] T. Smith. [5] T. Bryant.

Of the various instruments for inserting the thread, the spiral needle, *e* (Fig. 316), is the best, but the common curved needle with a firm needle-holder, *i* (Fig. 316), may answer in emergencies.[1]

First decide how many sutures will be required, and observe the points at which they should be inserted to correspond on each side; the sutures in each needle should be at least one yard in length, and each suture should be doubled for its whole length before being passed; with the needle in the right hand and a pair of long spring forceps in the left, push the point of the needle through the soft palate on the patient's left side, as near to its anterior margin as practicable; seize one thread of the suture and draw it forwards; pass the needle on the opposite side with a double thread, the loop of which should be drawn out; the needles being removed, the single thread of the one side is passed through the loop of the other, the looped thread withdrawn from the palate carrying the single suture through the opposite side (Fig. 323);[2] repeat until the requisite number, three or four, is inserted; tie each separately, and not too tightly, to allow for swelling; a slip-knot (Fig. 323) to bring the edges together, and a second knot over that, are sufficient (Fig. 324); the ends should not be cut off very close.[3] A perforated shot may be passed over the suture, and a knot tied to prevent slipping (Fig. 326). If wire is used, it must be applied with the wire adjuster, *c* (Fig. 316), be nicely twisted, and cut closely. The after treatment must be carefully attended to; the diet should be liquid; no conversation should be allowed; the sutures may be removed after about eight days.

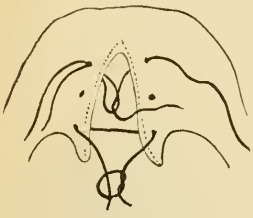


Fig. 323.

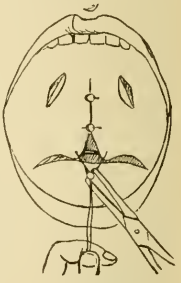


Fig. 324.

2. **Uranoplasty**, closure of fissure of the hard palate, may be undertaken at any age, yet as the real object of the operation is to enable the patient to articulate plainly and intelligibly, and as a child does not commence to articulate, as a rule, before twelve months old, nor to pronounce many words before two years of age, the reasons are strong against its performance prior to this latter period of life, for the child is now in a much more favorable condition to undergo the operation, and less liable to succumb to the effects of the loss of blood. The early treatment, therefore, is the proper nourishment of the infant until it reaches the requisite age, and the mother's

[1] F. H. Hamilton. [2] J. Bell. [3] G. Pollock.

milk is the only food that should be given for the first six or eight weeks; if the child cannot nurse, owing to the extent of the cleft, it must be hand-fed with her milk.[1] The operation, whatever may be the extent of the fissure, consists in dissecting up the membrane covering the hard palate, quite back to the alveolar processes,[2] including the periosteum so as to form muco-periosteal flaps.[3] The result will be successful in any case where the patient is fairly healthy and the parts can be brought together without undue tension.[4] The closure is effected not only by these soft tissues, but also by bone subsequently reproduced in the periosteal layer.[5] As the success of the operation depends upon immediate union of the edges of the flaps, examine the patient carefully to ascertain if he is in a condition of health to justify the expectation of union by first intention; if there are any signs of disordered health or defective power, as pustules, herpes, excoriated lips or nostrils, the operation should be postponed.[1] The operation may be completed at one,[2] or at several sittings;[1] unless there are circumstances of peculiar difficulty in the case which will make the operation either unusually tedious or will necessitate such an extensive division of the soft parts as would endanger the flaps, the whole cleft should be closed at one operation.[4]

In an ordinary case of cleft of the hard and soft palate proceed as follows: Place the patient, etherized, in a good light; introduce the gag previously fitted to the mouth (Fig. 317); or, if the cleft is through the alveolar process also, select a gag[4] which has no central roof portion.[6] Operate first on the soft palate; pare the edges of the cleft from below upwards, the point of the uvula being held with forceps, *b* (Fig. 316), to render it tense; apply the sutures from below upwards, passing them, if possible, completely through both sides to avoid the loops described, and fastening each after the next is passed; relieve the undue tension by longitudinal incisions on either side parallel with the cleft, and just internal to the hamular process, avoiding the post palatine foramen,[4] or cut the muscles, seizing with the forceps, *b* (Fig. 316), the palato-pharyngeus muscles and dividing them with the scissors, *f* (Fig. 316), low down, and also the levator palati, of both sides.[7] When the soft palate has been closed and the point in the velum has been reached where the sutures can no longer be fastened, from the amount of tension, proceed to operate on the hard palate, if the condition of the patient do not forbid it.[4] Separate the soft tissues from the bone, commencing at the edge of the cleft and dissecting outwards to the alveolar process;[2] or, which may be preferable, from the alveolar border towards the fissure,[8] as follows: make an incision close to and par-

[1] G. Pollock. [2] J. M. Warren. [3] Von Langenbeck. [4] T. Smith.
[5] Von Langenbeck; W. R. Whitehead. [6] J. L. Little. [7] W. R. Whitehead.
[8] G. Pollock; W. R. Whitehead; Von Langenbeck; F. Mason.

allel with the alveolar ridge, from a point opposite the last molar tooth forwards to the canine, and separate the flaps from the bone by means of the periosteotome, *h*, *i* (Fig. 316), commencing at the incisors and proceeding inwards to the edge of the gap, avoiding bruising the flaps; these flaps should now fall inwards and downwards and meet in the median line without the slightest traction; if the edges do not readily meet, the flaps have not been sufficiently detached, and search must be made for the point preventing descent, which should be freely liberated; pare the edges with a sharp knife so that two entire and fresh raw surfaces are brought accurately in contact; pass the sutures as in closure of the soft palate.[1] No special treatment is required, except to avoid giving warm food until the day after the operation, and to abstain from looking at the palate; give first iced milk, and afterwards, for a fortnight, such food as eggs, milk, rice milk, cream, custard, stewed fruit, arrowroot, soup, beef tea, pounded meat, with wine, brandy, or malt liquors; children and delicate young persons should be kept in bed for a week, when practicable; the sutures should remain three weeks or a month in children, and be removed under an anæsthetic.[2]

It frequently happens that under the most favorable circumstances a small aperture will remain; these openings are not unlike those slight congenital defects which appear in the palate as orifices, or which result from syphilitic caries; they may be closed with a metal plate,[1] or with a hard rubber obturator,[3] or by subsequent operations.[4]

II. CONTRACTION OF SOFT PALATE.

Contracted soft palate frequently results from successful closure of the cleft, and leads to imperfect speech. With a view to lengthen the curtain or relieve the tension upon it, several operations have been performed: (1.) The inner borders of the palato-pharyngeus muscles have been pared and united, but the operation had the effect of compelling the patient to breathe entirely through the mouth, without improving speech.[5] (2.) The attachments of the palate to the sides of the fauces, together with the anterior and posterior pillars may be divided as follows: pass a spatula behind the soft palate, 1, 2 (Fig. 325) both to steady and to draw it forward, then, transfix the soft palate by a sharp pointed bistoury by the side of the spatula and at the inner edge of the hamular pro-

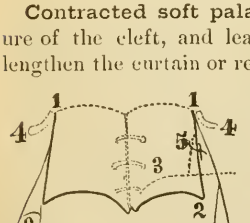


FIG. 325.

[1] G. Pollock. [2] T. Smith. [3] J. M. Warren. [4] W. R. Whitehead. [5] Passavant.

cess 1, 4, and cut through the free margin of the palate to 2 (Fig. 325), dividing the tensor palati, palato glossus, and palato-pharyngeus muscles; retraction follows, 3; sutures are now passed through the sides of the flap from before backwards, thus hemming the mucous membrane, 5; this operation is extremely simple, comparatively painless, and has always resulted in some, and, in many instances marked, improvement of the voice.[1] (3.) Dissection of the palato-pharyngeus muscles to form flaps in connection with a raised portion of the mucous membrane of the prevertebral region was attempted but not completed.[2]

III. THE UVULA.

The special instruments adapted to operations on the uvula are (Fig. 328): forceps for holding the tongue, *a*; a vulsellum, *b*; uvula scissors with claws, *c*; a uvulatome, *d*; double hook, *e*.[3]

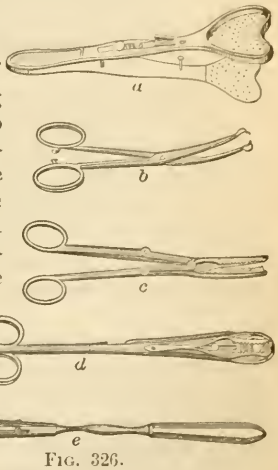


FIG. 326.

1. **Elongated uvula** is the result of chronic inflammation; the lengthening may be slight or so great as to fall into the larynx. Excision, a very simple operation,[4] should be performed thus: the patient sitting upon a chair in front of a good light, seize the tongue with the broad spatula, *a*, or direct the patient to withdraw it from the mouth by seizing the tip enveloped in a handkerchief; seize the apex of the uvula with the forceps, *b*, or double hook, *e*, and cut off with the serrated scissors slightly curved, *c*, or uvulatome, *d* (Fig. 326), about two thirds of the organ.

2. **Abscess** occasionally forms in the soft palate as a result of inflammation which often extends from the tonsils; when pus is recognized, puncture with a knife having a sharp point and a narrow blade; pass this directly backwards.

3. **Tumors** appear in the soft palate, and are either fibro-cellular, cystic, or warty; the former are usually pendulous, attached to the free border or upper surface of the palate, of slow growth: remove them with forceps and scissors. Cysts result from obstructed ducts, commonly contain thin glairy fluid, and are treated by incision and the application of nitrate of silver. Warty growths springing from the mucous membrane should be removed with scissors.[5] Polypi may

[1] F. Mason. [2] W. R. Whitehead. [3] H. Green. [4] S. D. Gross. [5] G. Pollock.

appear on the posterior surface, and give rise to cough owing to their pendulous condition; they may be easily removed with scissors.[1]

CHAPTER XXXII.

THE ALVEOLAR PROCESS; THE SALIVARY GLANDS; THE TONSILS.

I. THE ALVEOLAR PROCESSES.

These parts are the thick pyramidal ridges of the maxillæ which arch from behind forward and inward; the free margins present the orifices of a number of deep conical pits, the sockets for the insertion of the teeth; the outer surface is marked by alternating vertical ridges and depressions corresponding with the alveoli and their intervals.[2]

1. **Abscess** is caused by inflammation of the alveolo-dental periosteum. A sac forms at the apex of the tooth which finally suppurates with absorption of the fluid; the gums swell and become painful, the accumulated pus ultimately makes an opening through one side of the socket, opposite the extremity of the root, the pain meantime is deep-seated and throbbing until the pus escapes.[3]

The pointing of the abscess upon the face appears to depend upon either an unusual length of fang or a superficial reflection of the mucous membrane from the jaw to the cheek.[4]

In an early stage prevent suppuration by means of leeches or the extraction of the tooth or its filling; when pus is detected, puncture with a sharp-pointed knife; if it threaten to open externally, remove the tooth and make an incision between the cheek and the jaw so as to cut across the pus-containing canal, and dress the wound with oiled lint to prevent union.[4]

2. **Epulis** is an innocent tumor, hard, and densely fibrous, composed of fibrous tissue and myeloid cells, and involving the periosteum; it grows slowly and evenly from the edge of the alveolar process, usually between two standing teeth, more often on the external than internal surface, though it may spring from any part; it generally makes its first appearance beneath and involving the little tongue of gum which exists between the necks of two contiguous teeth; finally it displaces the neighboring teeth, one usually more than the other, has a broad base, which increases more the projecting portion. The treatment is early and complete extirpation, not only of the tumor, but the teeth and all the gum from which it sprung; while any part of the gum remains it is likely to recur.[4] Excision is best

[1] S. C. Bussy. [2] J. Leidy. [3] C. A. Harris. [4] J. A. Salter.

effected by strong cutting bone forceps. Extract the involved teeth, and then cut the process on both sides of the growth completely through the alveolar border, and remove the mass with a knife or bone nippers.

3. **Hypertrophy** appears as a congenital affection, and consists of an expanded and prolonged development of the alveolar borders of the maxillæ, immense thickening of the fibrous tissue of the gum, and exuberant growth of the papillary surface. When fully developed, the patient presents an extraordinary appearance — a large mass, dense, inelastic, insensitive, pink and smooth, protrudes from the mouth.[1] Excision should be performed.

4. **Vascular growths**,[1] nævi and aneurisms by anastomosis form in the tissues about the necks of the teeth, especially between the incisors or canines and lateral incisors of the upper jaw; they have a purplish color, are smooth and streaked, with many vessels, are easily compressed and become pale and reduced, but are elastic and resume their previous aspect on removal of pressure; the whole gum is red, turgid, and swollen, and the little tongues of gum between the necks of the teeth are enlarged and spongy; troublesome hæmorrhage occurs later in the disease. Excision should be performed with a scalpel, the bleeding being controlled by pressure and ice.

5. **Warty growths**[1] are hypertrophied papillæ of the gum, which occasionally appear, sometimes in connection with warts on the lips and about the face. Excision should be practiced; and if there is a return caustics should be applied.

6. **Tooth tumors**,[1] odontomes, spring from the hard tissues of the teeth, and are classified as follows: (1) enamel nodules, pearl-like tumors on the fangs; (2) exostoses, small rounded nodules near the apex of the fang; (3) hypertrophy of fangs; (4) dentine excrescence, nodules of secondary dentine growing from the wall of the pulp-chamber; (5) warty teeth, the tissues being hypertrophied and folded into an irregular and complicated mass. Extraction of the affected tooth is necessary when the symptoms, as severe neuralgia, or the degree of malformation, demand interference.

7. **Dentigerous cysts**[1] are collections of serum in the maxillary bones, dependent upon impacted misplaced teeth; they arise only when the tooth or teeth associated with them are imbedded in the substance of the jaw-bone and do not occur after the tooth has pierced the gum; they occur in connection with the permanent teeth which may fail to pierce the gum, either from the great depth of the sac, or growth in an oblique direction, or from arrest of development. The symptoms are, expansion of the jaw-bone, weight, and tension, and disfigurement of the features; the diagnosis depends on pressure,

[1] J. A. Salter.

which reveals fluid, expansion of bone, and crepitation like stiff parchment, and absence of a tooth or teeth which have never appeared. The treatment consists in opening the cyst freely with knife, gouge, or trephine, extraction of the imbedded tooth, and, if the expansion is large, removal of the dilated bone; the result is always satisfactory.

8. **The extraction of teeth,**[1] though not strictly belonging to the province of the medical practitioner, must frequently be performed by him.

It is surprising that this operation should receive so little attention; this neglect can only be accounted for by the too prevailing belief that little or no skill is required for its performance; but it is the duty of every physician, residing where the services of a skillful dentist cannot always be commanded, to provide himself with the proper instruments and become acquainted with the manner of performing this operation.

The indications for the extraction of the temporary and permanent teeth are as follows: —

(1.) When a tooth of replacement is about to emerge from the gums, or has actually made its appearance, either before or behind the corresponding milk tooth. (2.) When the aperture formed by the loss of a temporary tooth is so narrow as to prevent the permanent tooth from acquiring its proper position without the removal of an adjoining temporary tooth. (3.) Alveolar abscess, necrosis of the walls of the alveolus and incurable pain in a temporary tooth. The indications for the extraction of the permanent teeth are: (1) when a molar has become partially displaced, or is a source of constant irritation; (2) when there is a constant discharge of fetid matter from the nerve cavity through a carious cavity in the crown, unless the discharge is slight, and the tooth is in the front part of the mouth and cannot be easily replaced; (3) when a tooth is the cause of an incurable alveolar abscess, unless the previous conditions exist; (4) when there is irregularity of the tooth due to disproportion between the size of the teeth and the alveolar arch; (5) when dead teeth act as irritants, or have become very much loosened.

Teeth may be extracted with the key or with forceps. The common tooth-key is a wheel and axle, the hand of the operator acting on two spokes of the wheel to move it while the tooth is fixed to the axle by the claw.[2] The straight shank, with a small round fulcrum slightly flattened on each side, is preferable to any other; there should be several hooks of different sizes, the edges of which should resemble the eagle's claw;[1] operate as follows: separate the gum from the neck of the tooth down to the alveolus, and round the entire tooth, with a straight, narrow-bladed knife, pointed at the end and with one cutting edge; attach the proper hook, and apply the fulcrum upon the inside of the edge of the alveolus, the extremity of the claw being pressed down upon the neck on the opposite side, grasp the handle with the right hand, and by a firm, steady rotation of the wrist, raise the tooth from its socket.[1]

[1] C. S. Harris. [2] Arnot.

For the removal of a tooth on the left side of the lower jaw, or the right side of the upper, the palm should be beneath the handle; for the other teeth it should be above; where the external surface of the tooth is decayed, the fulcrum must be placed on the outside (Fig 327).

Fig. 327.

The forceps are to be preferred to the key, for in the majority of cases they can be used with greater ease, and much less pain. Though there is a great variety of forms, but four are required for general use. These are arranged in two sets, one adapted for the incisors, *a*, below, and *b*, above (Fig. 328) and cuspids, and the other for the bicuspids and molars, *c*, below, and *d*, above. Operate as follows: detach the gum from the neck of the tooth, unless the claw of the forceps is sharp and sufficiently separates it; grasp the tooth firmly at the alveolar edge, but do not compress the handles of the forceps too tightly; move the tooth outwards and inwards, in quick succession, until it is loosened, and then draw it from its socket in a line with its normal axis.

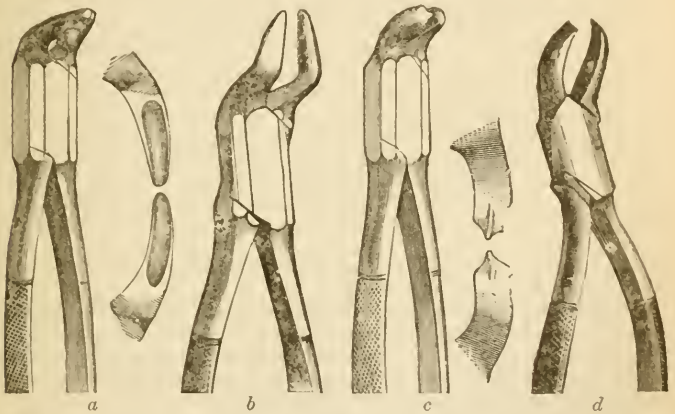


Fig. 328.[1]

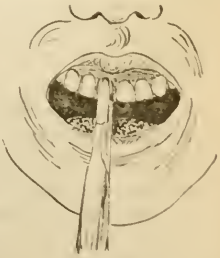


Fig. 329.

For the incisors, strong, straight forceps may be used (Fig. 329), and a slight rotary motion should be given to the tooth; the cuspids require greater force, due to the length of their roots; very little rotary motion can be given to the bicuspids; the upper molars have three roots, are very firm, and must be grasped as high up as possible and pressed out and in until it yields; the superior dentes

[1] Geo. Tiemann & Co.

sapientiæ are usually less firmly articulated and are easily removed with the bicuspid forceps; the inferior molars have two roots, but are very firm, and the decayed tooth is liable to be overlapped by the crowns of the adjoining teeth, which may require filing off to admit of removal; the dentes sapientiæ of the lower jaw, when situated far back, are oftentimes exceedingly difficult to extract, especially when the roots are turned posteriorly towards the coronoid process; in this case the loosened tooth should be pushed backwards, describing the segment of a circle as it is raised.

II. THE SALIVARY GLANDS.

These form a series of conglomerate glands arranged in a curved manner, and following the circumference of the inferior maxilla from the posterior border of one side to that of the other, and pouring their secretion into the mouth by means of excretory ducts.[1]

1. **The parotid**, the largest in the series, is bounded above by the zygoma; below by a line drawn backwards from the lower border of the jaw to the sterno-mastoid muscle; behind by the external meatus of the ear, the mastoid process, and sterno-mastoid muscle; its anterior border lies over the ramus of the lower jaw, and stretches forward to a variable extent on the masseter muscle; the deeper parts extend far inwards between the mastoid process and the ramus of the jaw towards the base of the skull; the excretory duct [2] passes off from the anterior border of the gland, one finger's breadth below the zygoma, runs forwards over the masseter muscle to the anterior border, turns inwards through the fat of the cheek, pierces the buccinator muscle, runs a short distance obliquely forwards beneath the mucous membrane, and opens upon the inner surface of the cheek by a small orifice opposite the crown of the second molar tooth of the upper jaw; a line drawn from the middle of the upper lip to the meatus of the ear marks the course of the duct.[3]

2. **The submaxillary** is situated immediately below the base and the inner surface of the lower jaw and above the digastric muscle; its duct,[4] two inches in length, passes off from the gland to the side of the frænum linguæ, where it terminates close to the duct of the opposite side by a narrow orifice which opens at the summit of a soft papilla beneath the tongue.[3]

3. **The sublingual**, the smallest gland, is situated along the floor of the mouth, where it forms a ridge between the tongue and the gums of the lower jaw, covered only by the mucous membrane, and reaching from the frænum in front, where it is in contact with the gland of the opposite side, obliquely backwards and outwards rather more than an inch and a half; the ducts [5] are from eight to twenty in number and open along the ridge which indicates the position of the gland.[3]

1. **Wounds** involving these glands are not liable to be followed by fistula, for though saliva flows for a time through the incision the textures consolidate, and the wounded part is obliterated. If oozing of saliva prevent healing apply pressure, or touch the part with hot wire, when the fistulous opening will usually promptly close; if the excretory duct is wounded, as of the parotid gland, it is important to complete the incision into the mouth, if it has not penetrated so

[1] Cyclop. Anat. [2] Steno's. [3] Quain's Anat. [4] Wharton's. [5] Rivieri.

deeply, to allow a free escape of the saliva in that direction, and close the external wound with silver suture.[1]

2. **Abscess** may form, especially in the parotid, and generally runs an acute course with much excitement; the pain is excessive, the parts pit on pressure, there is inability to open the mouth, the fluctuation is obscure as the pus is firmly bound down by the fascia and capsule of the gland; the treatment is early and free incision, made vertically into the most prominent part.[1] Abscess may form in the course of the ducts from obstruction by concretions; in the parotid duct it appears as a soft, fluctuating swelling in the cheek, which may attain large size, but usually ulcerates when quite small and opens externally; in the submaxillary and sublingual ducts these abscesses open into the mouth; the obstruction should, if possible, be dislodged, and the abscess opened within the mouth; if the abscess of the cheek cannot be relieved it should be opened into the mouth, and the obstruction removed.

3. **Calculi** may form in any of the ducts of the salivary glands, but the sublingual and submaxillary are most frequently affected; they are generally of an ovoid shape, whitish color, rough, composed of phosphate and carbonate of lime with animal matter; when diagnosed they should be removed within the mouth by incision.[2]

4. **Fistulæ** may remain after wounds or abscesses involving either the glands or ducts which open externally. Fistula of the gland, fully established, is often very difficult of cure. The means which may be adopted are, (1) injections of iodine; (2) cauterization; (3) graduated compression; (4) plastic operations. When the parotid duct is implicated, the first step in the process of cure is to establish a free opening into the mouth, from the oral end of the duct; pass a fine probe, armed with several threads of silk, into the fistula, through the duct, into the mouth either direct or through the natural opening; draw the end of the seton in the mouth out at the angle and tie it to the end on the cheek; after a week or ten days the artificial fistulous communication with the mouth will be established, and the fistula in the cheek will then probably contract and close; if it do not, cauterization of the edges of the fistula will tend to hasten cicatrization.[3] This operation failing, pass a thread of silk or metal through the fistula, into the mouth, from before backwards; remove the needle, leaving the thread in place; thread the external end and reinsert the needle at the fistula and carry it forwards in a similar manner into the mouth; remove the needle and tie the two ends of the thread now within the mouth quite firmly; the loop cuts its way out, leaving a free internal opening of the duct; the edges of the fistula may now be freshened and united by a suture.[4] Or, the fis-

[1] J. Spence. [2] S. D. Gross. [3] Morand; T. Bryant. [4] J. Bell.

tulous tract may be destroyed by placing a wooden spatula against the inside of the cheek and with a large, sharp, saddler's punch removing it entire, and closing the external opening with a suture.[1]

5. **Tumors** of a cartilaginous nature appear by preference in the salivary glands, especially in the submaxillary and parotid. Pure examples of enchondroma are more often found in these glands than anywhere else.[2] They may involve a single or several lobes, or the entire gland; the latter is rarely found in the parotid, but is the more frequent form in the submaxillary; other concomitant affections may also be present, especially myxoma, and sometimes cancer and cancroid.[3] In some cases the cartilage represents merely the acme of textural evolution, while the main bulk of the growth is made up of mucous tissue, with spindle-cell and round-cell sarcoma tissue.[4] Tumors of these glands are not only cartilaginous, but are mostly encysted, and have a peculiar, hard, elastic feel, are generally embedded in the structure of the gland, varying much in depth, those which appear movable and superficial too often dipping well down into the tissues; they may grow to a great size, and stretch the skin over them.[5] The question of the removal of these growths must be determined by the conditions existing in each case; pure cartilaginous tumors of small size may be very easily removed; mixed tumors of large size involve extensive dissection among important parts, but they are often removed very satisfactorily; cancerous degeneration requires extirpation of the gland, which is always a formidable operation, but may be safely accomplished and be followed by variable periods of comparative comfort.[6] A safe rule to follow may be thus stated: when it is evident that the part glides freely over the subjacent textures do not hesitate to undertake removal, whatever may be the bulk of the disease; but if the tumor seems fixed, its limits not clearly defined, and its movement causes pain, hesitate about removal, however small the mass may be.[7]

Extirpation of the tumor requires a free division of the superimposed parts as a condition essential to success; make first an incision down to the tumor and through its investments, and then add others so as to form two or more flaps; carry the dissection to the lower boundary of the growth where the vessels are known to enter, and divide, compress, or tie them, as may be necessary, and thus much less blood will be lost, and the time occupied lessened; the utmost care must be taken to avoid, as far as possible, the branches of the cervical nerves and the portio dura by dissecting the posterior part of the tumor carefully, and in the direction of their course, the edge of the knife being turned towards the tumor; in some cases

[1] W. E. Horner; S. D. Gross. [2] E. Rindfleisch. [3] R. Virchow.
[4] T. Billroth. [5] T. Bryant. [6] J. M. Warren. [7] Sir W. Fergusson.

these nerves must be divided.[1] Extirpation of the entire gland must be effected by similar incisions and dissections, but in deeper structures the handle of the scalpel must be used as far as possible to detach or isolate lobes of the gland or portions of the tumor and disengage them from among the vessels; tearing out the lobes is more safe than incision; in extirpating the parotid, the greatest precautions should be taken when the dissection extends behind the lower jaw, for here the external carotid and the internal and maxillary arteries are found; if exposed, they should be tied; the styloid and digastric muscles should be saved, if healthy, and cut, if involved in the disease; if the tumor finally adhere firmly at the upper part, apply a ligature to the attachments; the arteries liable to be involved are the carotid, transverse facial, temporal, auricular, mastoid, stylo-mastoid occipital, internal maxillary, the inferior pharyngeal, and even the lingual and facial; the flaps should be united by suture, proper drainage being secured; the movements of the pharynx, larynx, tongue, and jaw are often permanently affected, and the muscles of the face paralyzed.[2] In extirpation of the submaxillary, make a crucial or semilunar incision of the skin over the gland, and tie and cut the vessels between two ligatures; seize the gland with a hook, draw it out and isolate it from the hypoglossal nerve and lingual artery by careful dissection; apply a ligature above the place where the gland is to be severed and separate it from its connections: close the wound accurately with sutures.[3]

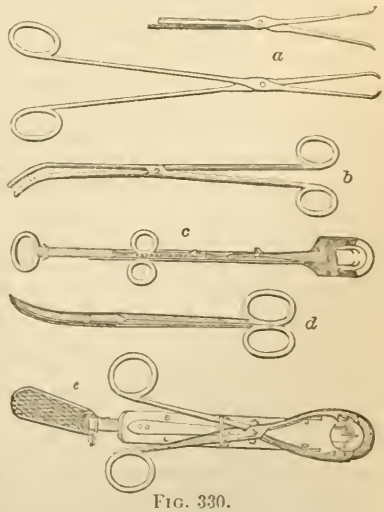


FIG. 330.

III. THE TONSILS.

These bodies occupy the recesses between the anterior and posterior pillars of the fauces and are about six lines in length and four in width and thickness.

The outer side is connected with the inner surface of the superior constrictor of the pharynx, lies near the internal carotid artery, and corresponds with the angle of the lower jaw externally;[4] it is covered on the external surface by a fibrous semi-capsule which facilitates enucleation of the gland.[5] The instruments required for operations on the tonsils are as fol-

[1] R. Liston. [2] A. Velpeau; V. Mott. [3] Bernard and Huette.
[4] Quain's Anat. [5] Chassaignac.

lows (Fig. 331): (1) tenaculum forceps for seizing, *a*, or forceps with curved serrated surfaces, *b*;[1] (2) tonsilotome, *c*,[2] or *e*;[3] tonsil scissors, *d*, curved on the flat.

1. **Abscess** of the tonsils must be punctured as soon as pus is detected, care being taken to avoid wounding the internal carotid artery. Select a broad spatula and a sharp-pointed, straight bistoury, wrapped to within about half an inch of its extremity; place the patient in a chair in front of a good light, the head firmly supported by an assistant; lay the spatula lightly on the tongue until the abscess is brought into view;[4] pass the knife backwards, avoiding wounding the tongue, and incline the point, when it penetrates the tonsil, towards the median line of the fauces, thus protecting the internal carotid from all danger; if the abscess cannot be sufficiently exposed it may be necessary to direct the point of the knife by the index finger of the left hand; if the abscess contain a large amount of pus the patient's head should be thrown forward immediately after the puncture to avoid the flow into the pharynx or larynx.

2. **Hypertrophy** of the tonsil is caused by repeated acute congestions of the pharyngeal mucous membrane, and consists of an equable and uniform overgrowth of all the histological elements of the follicles; the size and shape of the entire tonsil undergoes an alteration; it forms a globular and often pedunculated tumor which may project so far as to interfere with breathing.[5] Removal is required only in extreme cases, as when the voice is seriously affected, or the sleep is so disturbed as to impair the health, or the secretions of the ducts are very fetid.[5] Excision may be performed with curved hook-teeth forceps (Fig. 330, *a*, *b*) and a straight probe-pointed or curved scissors (Fig. 330, *d*), or with the tonsilotome (Fig. 330, *c* or *e*). If the patient is a child, give chloroform, and when sufficiently under its influence to open the mouth, seize the tonsil, draw it out from between the pillars, and having the knife-blade wrapped to within an inch of its point, cut away from below upward the proper amount; if an adult, place him in a chair in a good light and incise with the knife or the tonsilotome. If the latter is used, adjust the ring to the gland on its inner and lower aspect, with the index finger ascertain that the gland is embraced by the ring; with the thumb and finger of the same hand close the forceps, draw the gland through and project the knife with the thumb of the right hand. Or, the instrument may be automatic (Fig. 331), requiring, when once applied to the tonsil, only the closure of the handles, both to seize, draw out, and excise the gland; if the hæmorrhage is too free, use ice applications, or ice-water gargle.

[1] Musseux. [2] J. S. Billings. [3] F. H. Hamilton. [4] G. Pollock. [5] E. Rindfleisch.

3. **Cancer**, encephaloid, may appear in the tonsil, as a primary or secondary disease, and has been treated by extirpation of the gland. Removal by external incision is to be preferred, for excision from within is liable to uncontrollable hæmorrhage and secondary sloughing; though the external operation is dangerous, owing to the depth of the wound, the proximity of the internal carotid artery and the crossing of the hypoglossal, gustatory, and glosso-pharyngeal nerves, there is no other risk than the liability to pharyngeal fistula.[1] Amygdalotomy requires a knife, clawed, dissecting, and artery forceps, and ligatures; the shoulders being raised and turned to the opposite side, make an incision extending from just within the angle of the jaw, downwards, over the most prominent part of the tumor, three inches and a half, parallel with the sterno-mastoid muscle; make a second incision, meeting this along the lower border of the jaw one and a half inches; dissect the soft parts until the diseased growth is reached, dividing the stylo-hyoid and stylo glossus muscles and separating the fibres of the superior constrictor of the pharynx; arteries cut, as the facial, must be promptly ligated; the gland must now be enucleated and separated from surrounding parts; close the horizontal wound with a suture, but leave the other open; liquid nourishment should be administered by the stomach-pump until the wound is sufficiently closed.[1]

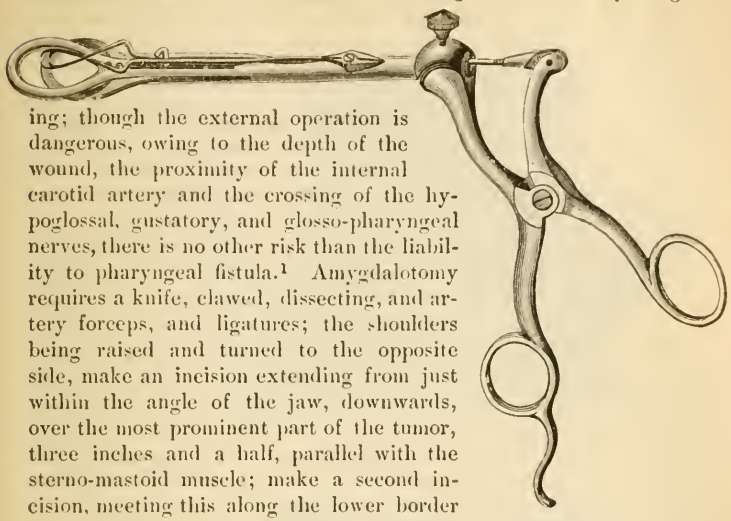


Fig. 331.[2]

CHAPTER XXXIII.

THE TONGUE.

The tongue is a muscular organ covered with mucous membrane; posteriorly it is connected with the hyoid bone; inferiorly it receives, from base to apex, the fibres of the genio-glossus muscle, by which it is attached to the lower jaw; the ranine arteries run along the lower surface from base to apex.[3]

[1] D. W. Cheever. [2] Tiemann & Co. [3] Quain's Anatomy.

The only special instruments required for operations on the tongue are the écraseur, and the galvano-cautery. The écraseur [1] (Fig. 332) is especially adapted [2] to the removal of diseased structures in highly vascular tissues, as in the removal of malignant disease of the tongue, hæmorrhoids, cancerous affections of the anus, uterine polypi; of the various modifications none are equal in practice to the original instrument; the resistance encountered in tightening it proves the density of tissue; every click measures accurately the progress of the chain, and it finally cuts neatly through without throwing out long shreds of tissue, leaving the operator in doubt when the tumor is entirely severed, if it is hidden from view; the difficulty of carrying the chain around the tumor when the latter is situated in the vagina or uterus, has been the only obstacle to its use; this defect is now supplied by the porte-chaine, added to the original instrument, which consists of a pair of dilating forceps with spring blades, which render the chain tense, so that it may be passed straight into the vagina or into the cavity of the uterus as easily as a sound, after which the chain is expanded by the blades of the porte-chaine. Galvano-cautery is cauterization by a resisting wire heated by the galvanic current; this effect is in accordance with the law of electricity, that when it passes through a resisting wire it raises the temperature in proportion to the resistance of the wire and the quantity of electricity, and the wire thus heated is capable of producing cauterizing effects; as platinum offers the greatest resistance to the current it is preferred. A universal electrode for galvanic cautery operation is now provided [3] (Fig. 333), which combines strength, lightness, durability, and perfect reliability,

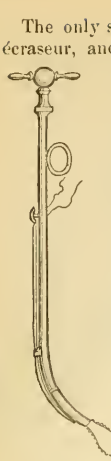


FIG. 332.

FIG. 333.

whether used as a galvanic cautery, écraseur, or cautery knife, needle, or applicator: *A* is a solid hard rubber handle through which pass the conducting rods *C C*, connected with the battery wires at *B;* the rods at *C C* being hollow half their length admit of the rods running from the ivory tip *E* to slide in and out like a telescope, which they are made to do by turning the small wheel *F;* this telescoping of the rods keeps up perfect current connections and at the same time causes a slow contraction of the wire cautery loops at *E*, the ends of the wire being secured in the ivory clamp *G* in the rods *C C;* the current is regulated, or cut off and on, from the battery by the screw *D;* three other cautery instruments of different forms may be adjusted to the handle, which are used by withdrawing the tip *E* with its rods, and adjusting the individual cautery, that may be requisite, with open ends of the rods *CC;* the battery (Fig. 334) is composed of but two cells, in each of which are two positive (zinc) and one negative (platinum) plate, all measuring but four and a half by six inches; the zincs *A*,

[1] E. Chassaignac. [2] J. M. Sims. [3] B. F. Dawson.

are perforated, and adjusted but half an inch apart, and between them a platinum plate is placed, and held in position by uprights *B*; on each side of the platinum plates are hard rubber or celluloid pumps or agitators, *C*, worked by means of a small knob; *D* and *E* are the connecting screws, and *F* a knob for lifting the battery out of the cells; the battery requires but two and a half pints of fluid, with which amount it will keep up a most powerful action, long enough for the most prolonged operation, by the moving up and down of the pumps, *C*, which, according to the intensity of the heat desired are moved more or less quickly; by this action, the old and exhausted fluid between the plates is thrown out through the perforations, and fresh fluid is made to take its place, thus keeping up a uniform power.

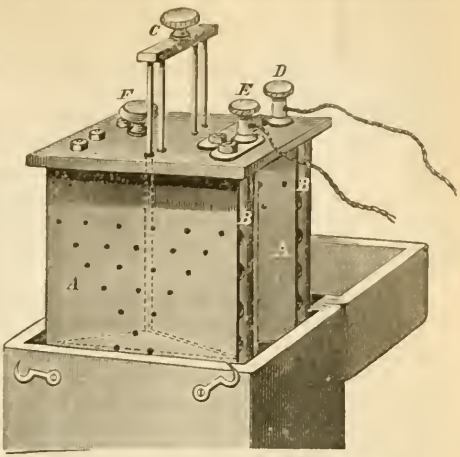


FIG. 334.[1]

The galvano-cautery is especially adapted for the removal of tumors that are not readily accessible by other means, and vascular growths that would be attended with severe hæmorrhage; its advantage in the removal of the tongue are, therefore, that (1) it saves all hæmorrhage; (2) it combines the after-cauterizing effects with the other results of the operation, sometimes desirable; (3) it is but little painful after the operation and is never dangerous; its disadvantages are the difficulty of obtaining and managing the necessary apparatus.

1. **Tongue-tie** is a congenital malformation in which the frænum-linguæ extends too far forwards towards the point of the tongue, and remains rather below its natural height, measured from the floor of the mouth; protrusion is hindered, and where the defect is great the tongue cannot be applied against the roof of the mouth; the slight form is harmless, but the severe form presents a great obstacle to sucking; in the latter case it is advisable to operate.[2] Division has been followed by fatal hæmorrhage from the ranine arteries;[3] but carefully performed it is without danger and painless; pass[2] the first and second fingers of the left hand, palm downwards, under the tip of the tongue on either side of the frænum, and

[1] G. Tiemann & Co. [2] T. Holmes. [3] F. H. Hamilton.

put it well on the stretch; snip the edge of the frænum with blunt-pointed scissors below the fingers, thus escaping the ranine arteries which run along the lower surface of the tongue; push the tongue upwards against the roof of the mouth, and divide further, if necessary; this method is preferable to the use of the cleft in the handle of the ordinary director.

2. **Wounds of the tongue** are liable to be followed by hæmorrhage; use styptics, ligature, or the actual cautery; these wounds unite readily; the treatment is to clean the wound of shreds, and close with sutures; if the wound is so extensive that the tongue is partially severed, it must still be united; if the tongue has a tendency to fall backwards, pass a ligature through the tip and fasten it to the teeth or externally.[1]

3. **Glossitis** is generally attended by a sudden swelling or œdema of the tongue, threatening suffocation. The remedy is free and deep longitudinal incisions; they should be made along the upper, rather than the under surface, to avoid the ranine arteries; when one side is involved the œdema may be so great as to cause the lower surface, which yields the more readily, to be turned directly upwards, when the incision must be made with great care.[2]

4. **Polypi** appear on the under surface of the tongue, as elongated growths, sensitive to the touch and the source of much annoyance; they consist of a stroma of connective tissue, infiltrated by small, round, nucleated cells, and covered by nearly normal epithelium. Excision with scissors, and injection of the base with pure acetic acid with the hypodermic syringe, has effectually destroyed them.[3]

5. **Abscess** appears as a firm tumor, imbedded in the substance of the tongue, after acute inflammation, and must be treated by incision.

6. **Ranula** is a cyst beneath the tongue, but intimately related to the salivary ducts. The ducts becoming closed, the epidermic lining is deposited in the interior,[4] and the secretion accumulates until a large tumor is formed which presses the tongue upwards and backwards, greatly interfering with the functions of that organ. These cysts are readily recognized on inspection of the under surface of the tongue. The treatment is free incision, and keeping the wound open; if this fail, excision of a portion of the walls is necessary; if the disease persists, open the cyst and cauterize with nitrate of silver, or even nitric acid.[5] If the cyst project in the neck, open it in the middle line below the hyoid bone, and keep it open till the cavity is obliterated.

6. **Hypertrophy** is usually congenital, and may be noticed imme-

[1] S. D. Gross. [2] H. Coote. [3] S. C. Bussy. [4] T. Billroth. [5] T. Holmes.

diately after birth, or may appear later, being uncertain in its rate of growth; when fully developed the tongue protrudes, with constant dribbling of saliva, and causes deformity (Fig. 335) of the jaw.[1] The treatment by pressure and astringents may first be attempted, as follows; apply daily, cupri sulph. ℈j. to aq. ℥i. on lint, and compress with a bandage.[2] If these means fail, removal is the only alternative. Excision is very dangerous when the organ is great, owing to hæmorrhage; the knife, ligature, écraseur, or galvano-cautery may be employed; when the knife is used the flaps may be made by transfixing the tongue laterally or vertically; the former method is, in general, preferable, as the thickness of the tongue is thereby much more reduced.[3] The head being supported against the breast of an assistant, who retracts the angles of the mouth, seize the tongue with forceps on its edges, and draw it well forward; pass a strong ligature transversely through the back part of the tongue with which to draw the organ forward; transfix the tongue from side to side at the point where excision is to be completed, and cut forward and downward, through its under surface, making the lower flap; form the upper flap by cutting in a reverse direction, backward and downward, to the point where the first section had commenced; ligate the arteries and secure the flaps in contact with sutures; recovery with a flattened tongue and good speech results.[3] A vertical incision may be required, in order to remove a V-shaped portion of sufficient size, and bring together the lateral flaps so as to form a new tip, which shall fall within the teeth; the patient, anæsthetized, being placed with the head elevated and held by an assistant, pass the knife through the substance of the tongue external to the middle line, to avoid the ranine artery, cut out a flap, and tie all the bleeding vessels; pass a strong ligature through this flap to prevent the tongue falling back; enter the knife at the same point; carry it across the middle lines, dividing the ranine arteries, which must be tied before the flap is finally separated; close the wound with strong sutures thus: introduce these sutures into the lateral flaps (Fig. 336), and on tying them the tip of the tongue assumes a natural appearance (Fig. 337). Removal by the écraseur involves less immediate risk from hæmorrhage, but is liable to be followed by dangerous inflammatory swelling. If employed, proceed thus: pass the chain of a very stout instrument through the substance of the tongue, at the same point as in excision by the knife, and when it has worked its way outwards a

FIG. 335.[3]

[1] T. Holmes. [2] J. Syme. [3] G. Buck.

little, pass a second chain and work it at the same time towards the opposite side.[1]

7. **Cancer**, in the form of squamous epithelioma, has a favorite seat in the tongue; the primary nodule is nearly always situated on one or other side of the organ, and is distinguished by its softness and tendency to seedy disintegration; on removal, it returns, and the interval between removal and return grows shorter each time until the

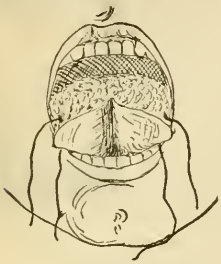


FIG. 336.

FIG. 337.

entire tongue is destroyed.[2] Scirrhus commences as a firm incompressible knob on the edge of the organ, often opposite the last molar tooth, or so far towards the root as to be beyond reach; the symptoms are, soreness, painful deglutition, salivation, pain in the course of the Eustachian tube, ulceration, hæmorrhage, infiltration, of absorbent glands.[3] Excision of the diseased part or extirpation of the entire tongue are the operations recommended. The motive to operate here is not greatly to prolong life, yet enough is gained to justify an operation which is attended with very little suffering or risk, but rather to secure future comfort, which in many cases is so great as to justify a greater risk of life than is incurred in any of the ordinary operations for the removal of cancer of the tongue; though the disease return after the operation, it is unreasonable to refuse, on that account, a painless operation, and one free from risk to life; if the patient has but two or three years to live, it is no small advantage if at least half the time can be spent in comfort, rather than in misery; in profitable work, rather than in painful idleness.[4] Removal of a portion of the tongue may be performed with the knife, the écraseur, the ligature, or the galvano-cautery; the knife is preferable to the écraseur in all but the largest operations; the ligature is rarely required, and the caustic is to be used only where the disease is limited.[4] In the removal of the tongue for cancer, by the knife, the ligature of the lingual artery near its origin has proved an important preliminary step, as it is less difficult than securing the vessels in the wound

[1] T. Holmes. [2] E. Rindfleisch. [3] H. Coote. [4] Sir J. Paget.

during the operation, controls all hæmorrhage, and may have a tendency to retard the return of the disease.[1]

In operating with the knife select a straight blade, or use scissors with serrated edges, and stout hooked forceps; place the patient in a chair, without anæsthetic, if consent is obtained, the head supported, and the tip of the tongue held by the fingers of an assistant, either with the aid of a towel, forceps, or ligature passed through it; seize the tumor completely within the blades of a double-hooked forceps, and with the knife sweep away the entire diseased mass, tie any bleeding artery, and control hæmorrhage with ice; use no other ligatures, nor sutures, to avoid irritation, but allow the wound to heal by granulation.[2] The écraseur may be used when the excision involves one or both ranine arteries; pass the chain around the mass (Fig. 338), or through the centre of the tongue, tighten it by one turn every two minutes until it divides both sections. The amount of tongue that can be removed through the mouth by these means is measured only by the appliances the surgeon has at his command to fix its posterior boundary.[3] By dividing all the muscles uniting the jaw and hyoid bone on both sides, as near the jaw as possible, the tongue may be drawn almost entirely out.[4] Galvano-cautery may be used either (1) by drawing the tongue forcibly forwards and then passing stout pins through it, behind which the wire is placed and maintained in position; or (2) the double wire may be passed through the centre of the tongue by means of a strong curved needle and the needle being cut away, the ends of the wire on one side are attached to the electrode, and the division made, and then the other side is removed in the same manner; the wire should not be heated above a dull red heat.

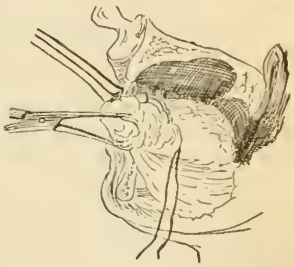


Fig. 338.

Extirpation of the entire tongue by the knife is most effectually performed as follows: Seat the patient on a chair, without an anæsthetic; extract one of the front incisors, and make an incision through the middle of the lip down to the hyoid bone; saw through the jaw in the same line; now pass the finger under the tongue and divide mucous lining of the mouth with the attachments of the genio-hyo-glossis; while the two halves of the jaw are held apart, dissect backwards, cutting through the hyo-glossis along with the mucous membrane covering them, so as to allow the tongue to be pulled forwards, and bring into view the situation of the lingual arteries,

[1] G. F. Shrady. [2] H. Coote. [3] T. Bryant. [4] Sir J. Paget.

which must be tied on both sides; now cut away the tongue from its attachment to the bone, protecting the knife with the finger passed over to the os hyoides; ligate arterial twigs and close the wound.[1] The tongue may be extirpated by opening the mouth by a semi-lunar submental incision and thoroughly detaching the muscles and other soft structures from the bone, and, when necessary, making also a vertical incision down to the hyoid bone.[2]

The écraseur may be employed with the common wire rope, or with the galvano-caustic. The former has been used very successfully, as follows: select a sharp-pointed, curved blade, about four inches long, and of sufficient thickness and breadth to carry the wire rope of the écraseur; the rope should be sufficiently stout, and the middle attached by a piece of string to an eye made in the broad end of the blade; cauterizing irons and the solid perchloride should be at hand; place the patient in a semi-recumbent position without anæsthetic, and enter the knife in the median line between the base of the jaw and the hyoid bone, but nearer the latter, and carry it into the mouth at the frænum linguæ, with the loop of wire; draw a good-sized loop through, and cut off the needle; pass the loop over the base of the tongue, which should be drawn forcibly forward by forceps; pass two or three long and strong hare-lip pins, slightly curved at the points, from the under side of the anterior attachment of the tongue, one on each side and the third in the middle, through its substance and on its upper surface as near to its base as possible; their points should just appear on the upper surface to prevent the slipping of the wire, but they are not absolutely necessary; tighten the wire slightly, and give an anæsthetic; now slowly turn the screw of the écraseur while the tongue is forcibly extended; more force is often required than was anticipated, but the wire must not cut through too rapidly; if there is too much hæmorrhage, which is very rare, tie any bleeding vessel, or apply the cautery; the after treatment consists in allaying inflammation of the part by pieces of ice, giving nutritious and opiate enemata; keeping the injured parts at rest; the submental wound heals by first intention, the local inflammation rapidly subsides, and the patient is soon able to swallow.[3] The submental incision may be avoided by forcibly withdrawing the tongue and dividing the attachments to the jaw, both in front where the genio-hyo-glossi muscles are inserted, and at the sides where it is connected with the mucous membrane.[4] The sublingual tissues may be divided by the écraseur itself, additional space being gained by incising the cheek below the angle of the mouth.[5]

Excision of half of the tongue, a part of each jaw, submaxillary

[1] J. Syme. [2] E. B. Regnoli; S. D. Gross. [3] Nunneley.
[4] Sir J. Paget. [5] M. Collis.

glands, and side of pharynx, have been successfully performed; the patient being under an anæsthetic, an incision was made from the angle of the mouth to the submaxillary region of the left side; the facial and lingual arteries and veins were tied; the upper jaw clipped with forceps at the posterior and lower corners; the lower jaw was sawn through at the canine tooth and immediately above the angle, the tongue drawn out and transfixed with a sharp-pointed, curved bistoury, from the middle line at the hyoid bone to the base of the epiglottis, and then slit to the tip; part of the soft palate and side of the pharynx were then separated with the rest; a pharyngeal fistula remained eighteen months after the operation.[1]

CHAPTER XXXIV.

THE PHARYNX; THE ŒSOPHAGUS.

I. THE PHARYNX.

The pharynx unites the cavities of the mouth and nose to the œsophagus, and extends from the base of the skull to the lower border of the cricoid cartilage, forming a sac open at the lower end and imperfect in front, where it presents apertures leading into the nose, mouth, and larynx.[2]

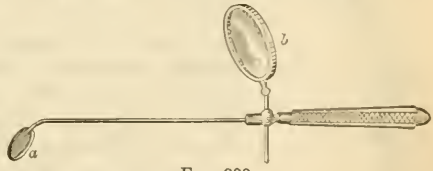


Fig. 339.

1. **Inspection of the pharynx** is so imperfectly made in the ordinary way with the common spatula or a spoon-handle, that it is important to be always provided with a suitable mirror, or reflector, which enables the operator to expose the cavity of the pharynx in the same manner as the larynx. For this purpose a simple pocket-mirror (Fig. 339) may be provided which both illuminates the pharynx

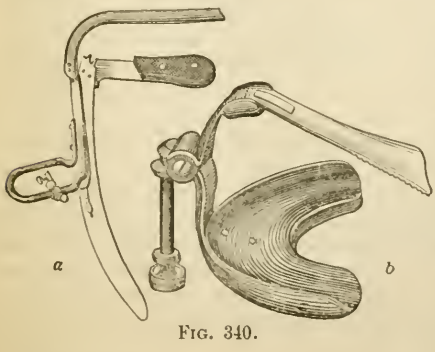


Fig. 340.

[1] R. Parker.

[2] Quain's Anatomy.

by the mirror, *b*, and reflects the surface by the second mirror, *a*.[1] For thorough examination of the pharynx a tongue depressor is also required (Fig. 340).[2]

2. **Wounds** may be incised or punctured, and are liable to serious complications from the depth of the tube and the important parts which surround it; if the wound is free, ingesta will escape externally; if not, abscesses and sinuses are liable to form.[3] Longitudinal wounds require no other treatment than approximation by adhesive plaster, but transverse wounds should be closed if possible, by suture, while the external wound is left open.[3] If the pharynx is nearly or quite severed, the wound will be opened and food escape at every effort of deglutition; to avoid this complication, a tube, as a catheter, or that of a stomach pump, must be regularly passed down below the wound, and nourishing fluids injected into the stomach.[4]

3. **Abscess** may form posterior to the pharynx, in front of the cervical vertebræ, in the submucous cellular tissue; it often appears in connection with caries of the vertebræ and disease of the lymphatic glands, is very insidious in its invasion, and tardy in its progress; slight difficulty of deglutition and breathing, with an inclination to snore, are often the first noticeable symptoms. On inspection, if the mouth can be opened sufficiently, a tumor is seen, of a reddish, livid, or purple color, bulging forward into the fauces, irregular in form; if examined with the finger, it will have a distinct sense of fluctuation on pressure; or the abscess may be acute, attended with deep-seated pain, great swelling, dysphagia and dyspnœa, and severe constitutional disturbance.[5] These abscesses should be opened at an early period by puncture through the mouth, either with a long, straight, narrow-bladed knife, having all of its blade protected except half an inch of its pointed extremity, by a pharyngeotome or, when it is very large, by aspiration; care should always be taken to prevent the contents of a large abscess from suddenly discharging into the larynx.

Fig. 341.[6]

4. **Foreign bodies**, if thin and pointed, as pins, needles, fish-bones, bristles, most frequently stick between one or other of the pillars of the fauces and the tonsil, or in the mucous folds connecting the base of the tongue with the epiglottis; if more bulky, they are arrested at or about the junction of the pharynx and the œsophagus. The symptoms of a small pointed body in any of these positions are

[1] L. Elsberg. [2] L. Elsberg; W. H. Church. [3] G. H. B. Macleod.
[4] A. E. Durham. [5] S. D. Gross. [6] G. Tiemann & Co.

local pain, with a pricking, increased on pressure behind the angle of the jaw; sometimes there is difficulty or pain in swallowing, with a disposition to vomit; when it is at the upper orifice of the larynx there may be cough and dyspnœa; if the body is large it usually causes death.[1] In every case, instead of wiping the parts roughly with a sponge, make the most careful attempts to discover and remove the body; if it is small, and not detected by the sight or finger, use a laryngeal mirror requiring the patient to inspire deeply while the tongue is depressed; when found, seize it with properly curved forceps (Fig. 341).[1] Or, employ the bristle probang (Fig. 342), which must be introduced, closed, below the foreign body, then spread out and slowly withdrawn. If the obstructing body is food, dislodge it with the finger, or by inverting the trunk, as of a child, and giving to the back in that region a smart blow, or by forcing it downward with a probang (Fig. 343). If asphyxia is threatened, perform tracheotomy or laryngotomy. If the body is irregular, and too firmly impacted to be removed without dangerous violence, open the pharynx, even though severe symptoms are present.[2] Pharyngotomy and œsophagotomy have the same details.

Fig. 342.[3]

j *k*

Fig. 343.

II. THE ŒSOPHAGUS.

The œsophagus commences at the cricoid cartilage opposite the lower border of the fifth cervical vertebræ, descends along the front of the spine, passes through the diaphragm opposite the ninth dorsal vertebræ, where it ends in the cardiac orifice of the stomach; its length is nine or ten inches.

Its narrowest part is at the commencement, and it is slightly constricted at the diaphragm; it has an antero-posterior flexure corresponding with the vertebral column, and two lateral curves to the left, one just below its commencement and the second near its termination: in the neck it is nearer the left than the right side, lies close behind the trachea, and the recurrent laryngeal nerves ascend in the angles between them: on each side is the common carotid artery, the left being in more immediate connection.[4]

1. **Medication** through the œsophagus by instruments may be effected by entering the tube at the mouth, or the nostril. Catheter-

[1] A. E. Durham.
[2] E. Arnott; E. Cock; D. W. Cheever.
[3] Tiemann & Co.
[4] Quain's Anatomy.

ism of the œsophagus requires a tube about thirty inches long (Figs. 350, 351), and the stomach pump. Place the patient in a chair, the head thrown back, and supported by an assistant; if the tube is passed by the mouth, depress the tongue with the left index finger, or a spatula; with the fingers of the right hand take the tube, well oiled and curved, as a pen, the concavity forward, and pass it gently along the posterior wall of the pharynx and œsophagus to the stomach, the head being thrown slightly forward as the tube descends; if the tube is passed by the nostril the patient should take the same position, and the surgeon should manipulate the tube as before, taking care to pass it cautiously along the floor of the nostril (Fig. 344) and the posterior wall of the pharynx; if the tube enter the larynx, violent symptoms, as cough and suffocation, are excited.

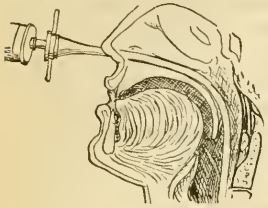


Fig. 344.

2. **Foreign bodies** are most liable to lodge opposite the cricoid cartilage, or just above the diaphragm, where the tube is most constricted; if small in bulk, but pointed, as a needle, it may stick in the mucous membrane a long time, or loosen easily by ulceration, or penetrate the walls; if large, hard, and irregular, deglutition is generally difficult, and serious results are early threatened; the diagnosis depends upon the history, and an examination by the hand.[1] The treatment consists in prompt removal; if the substance is digestible, endeavor to force it onward into the stomach by the probang; if indigestible, attempt to withdraw it by means of forceps, having a suitable curve (Figs. 345, 346, 347). Introduce them, well oiled, with the blades closed, using them as a probe, until the object is reached, when they should be opened and an attempt be made to seize the foreign body; if

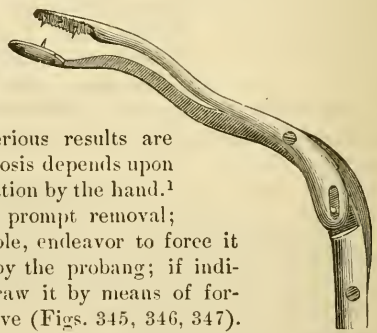


Fig. 345.[2]

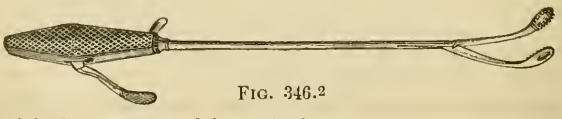


Fig. 346.[2]

successful, the most careful manipulation is necessary in withdrawing it to avoid lacerating the mucous membrane; if the body is small,

[1] G Pollock. [2] G. Tiemann & Co.

use a probang, to which a dry sponge is fastened, or a sound, to which a skein of silk is attached, so as to form a snare with a great number of loops, or the bristle probang (Fig. 342); these instruments should be passed beyond the obstruction and gently rotated

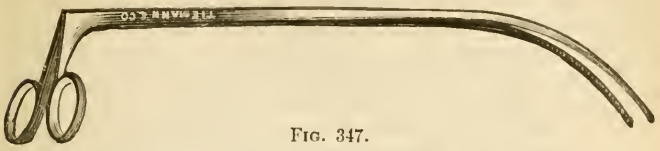


Fig. 347.

during its withdrawal; coins and such bodies may often be extracted with a flat blunt hook connected by a thin slip of steel to the end of a long whalebone probang (Fig. 348); vomiting induced by titillating the fauces, or injecting apomorphia into the arm, will sometimes dislodge a small body, but if the obstruction is firm, excessive vomiting may fix it more firmly, or rupture the œsophagus; if respiration is dangerously embarrassed, tracheotomy must be performed, and if the obstruction is below the point of operation, a tube must be carried down the trachea sufficiently to admit the air to the lungs. When, however, a solid substance, though only of moderate size and irregular shape, has become fixed at the commencement of the œsophagus, or low down in the pharynx, and has resisted a fair trial for its extraction or displacement, its removal should at once be effected by incision into that tube, though no urgent symptoms are present.

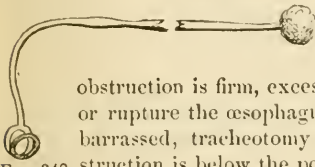


Fig. 348.

3. **Stricture of the œsophagus** is spasmodic or organic; the former occurs in hysterical persons, is intermittent, easily overcome by the probang, and disappears altogether under anæsthesia. Contractions resulting from cicatricial tissues or cancerous growth, occur chiefly on a level with the cricoid cartilage or the bifurcation of the trachea.[1] The leading symptom of organic stricture is gradually increasing difficulty of deglutition, with its concomitant distress and pain; if the patient is thin and the stricture high, it may sometimes be felt externally; to determine its presence and peculiarities, place the patient in a sitting posture, with the head thrown back, and pass an olive-pointed œsophageal bougie along the posterior wall of the pharynx down the tube to the seat of obstruction; the extent and condition of the stricture can now be made out. The cause may be an injury, syphilis, or cancer; the diagnosis in the early period depends upon the history; later, simple stricture is attended

[1] J. Orth.

with the discharge of a large amount of glairy mucus, and cancerous structure, with the escape of pus, blood, and shreds of tissue.[1] The treatment of the cicatricial form is by dilatation, and the cancerous on the expectant plan, or by gastrostomy.[2] Dilatation requires assorted rubber dilators;[3] place the patient in a chair, with the head thrown back; depress the tongue with the finger or a spatula, and holding the bougie as a pen, pass it along the posterior wall of the pharynx down to the obstruction, and gently insinuate the conical extremity into the contracted passage; the force used should be slight, the object being to open the stricture laterally and not push it downward; repeat the operation every second or third day, gradually increasing the size of the bougie as the stricture is enlarged; dilators containing air or water are more gentle and uniform in the pressure, but difficult and uncertain in management;[4] if the stricture is unyielding and deglutition becomes impossible, œsophagotomy may be performed below the stricture with a view to the introduction of nourishment into the stomach[5] by means of a suitable tube.

4. **Œsophagotomy.** 1, 2, 3, 4 (Fig. 349), is neither difficult of execution, nor necessarily accompanied with great risk, and has proved eminently successful, when early performed, for the removal of foreign bodies[6]; place the patient, fully anæsthetized, on the back, the head and shoulders slightly elevated, and face turned to the opposite side; if the foreign body project, make the operation at that point; if not, operate on the left side to which the œsophagus inclines; make an incision in the course of the depression between the sterno-mastoid and the trachea, extending from about opposite the upper border of the thyroid cartilage, nearly to the sterno-clavicular articulation, through the integument; divide the platysma myoides muscle and the cervical fascia; separate the edges of the wound and draw the omo-hyoid muscle outward or cut it; divide the outermost fibres of the sterno-hyoid and thyroid to sufficient extent; the carotid sheath is now fully exposed and should be drawn outwards with the sterno-mastoid and retained; separate the thyroid body as far as it may be necessary with the handle of the knife and draw it inwards; now draw the larynx somewhat forwards, turn it slightly upon its long axis, and pass the finger behind it to discover the position of the foreign body; if it is not found, pass a pair of long curved forceps well down into the pharynx, through the mouth, open them so as to press the walls of the tube well towards the wound as a guide, care-

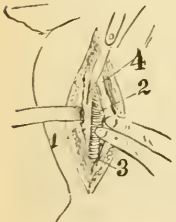


Fig. 349.

[1] G. B. Macleod. [2] T. Bryant. [3] P. S. Wales. [4] B. W. Richardson. [5] A. Willett. [6] G. Pollock.

fully avoiding the recurrent laryngeal nerve; open the tube sufficiently to admit the finger, and extend the cut upwards into the pharynx or downwards along the œsophagus, as may be necessary to reach the object sought; search for the foreign body with the finger, and when found, extract it by means of suitable forceps; the wound should not be closed with sutures; for the first few days feed the patient through a tube passed by the mouth below the wound.[1] The incision may be made in the median line, as for tracheotomy, the sterno-hyoid muscles separated, the isthmus of the thyroid body divided between two ligatures tied around it, the left lobe turned over and the œsophagus sought and opened behind it.[2]

5. **Resection of the œsophagus** is effected by the same dissection as that pursued in opening the tube.

CHAPTER XXXV.

THE STOMACH.

THE stomach occupies the left hypochondriac region, extending through the epigastrium into a small part of the right hypochondriac region.

Above it is the diaphragm and liver; below, the transverse colon; in front, the abdominal wall; behind, the pancreas; to the right, the liver; and to the left, the spleen.[3]

1. **Medication by the stomach** must occasionally be effected by instrumental means, as in the removal of poisons and the injection of foods and remedies. For these purposes the stomach pump (Figs. 350, 351) is required.

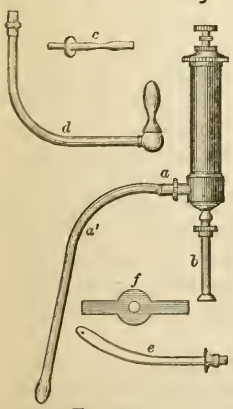


FIG. 350.

The lever *g* (Fig. 351) operates a valve causing either induction or eduction as the instrument may be required for use as a stomach pump or enema syringe; in the former case the flexible tube, *h*, is screwed to the lower end, and in the latter to the side branch of the instrument; the mouth-piece, *i*, is held between the jaws of the patient, the tube being introduced through its central opening. A stomach-pump (Fig. 350) may consist of a flexible suction-pipe attached to the lower

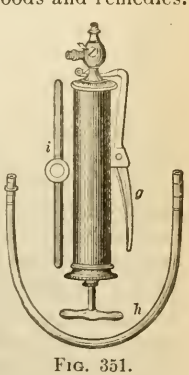


FIG. 351.

[1] D. W. Cheever; E. Cock. [2] E. Nélaton. [3] J. Leidy.

opening, *b*, and by working the handle the contents of the stomach are withdrawn and ejected through the branch, *a*; a quantity of warm water should be first pumped into the stomach; *d* is a tube for making injections; *f* is a gag or mouth-piece, placed between the teeth, through which the flexible pipe is inserted; *c*, *d*, *e*, are for enemas.

The pump is used as follows: place the patient in a chair, with the head thrown back and supported, and the mouth widely opened; oil the tube and curve the end slightly, that it may more readily follow the curve of the pharynx; press down the tongue with the finger and pass the curved end rapidly along the roof of the mouth into the pharynx, but without touching the soft palate, which is spasmodically drawn upwards; now bend the head slightly forwards to give a uniform curve to the cervical and dorsal vertebræ, and push the tube gently but firmly onward to the stomach; if resistance is encountered, withdraw it slightly and again press it forwards; the only danger is the liability of the tube to enter the larynx; if the patient is insensible, or resists the introduction, the gag *i* (Fig. 351), *f* (Fig. 350) must be placed between the teeth and the tube inserted through the hole; if the gag is not present, a tube may be passed along the floor of the nostril into the pharynx. If the tube is introduced to remove matters, as poisons, first inject warm water each time suction is made, and in excess of the amount withdrawn.

2. **Alimentation by fistula of the stomach** is indicated when death is imminent from inanition depending upon closure of the œsophagus, as from cancer, cicatrices from swallowing caustic matters, syphilis; the method of accomplishing this object is by the formation of a fistulous passage through the walls of the stomach and of the abdomen. The operation has until recently been followed by death in a few hours, or at most, a few days; but a period of forty days[1] finally supervened, and at length complete success was attained.[2] The failure, hitherto, has been largely due to the fatal nature of the disease of the œsophagus, and the delay in the operation; it is therefore, advisable, to operate earlier.[3] This is especially important since the introduction of the antiseptic method, for the danger of intervening peritonitis is comparatively slight. Chloroform should be given, unless the patient can be relied on to remain perfectly still, experience having proved that vomiting is not general.[4] Gastrostomy,[5] the formation of a fistula of the stomach, has been successfully performed as follows:[6] —

The case was stricture of the œsophagus, caused by swallowing acids, in a boy eight years of age. The skin was cut through for a length of about two inches, in a diagonal direction, running from right to left, parallel with the under side of the cartilaginous portion of the eighth left rib, and at a distance of a finger's

[1] S. Jones. [2] L. Verneuil; F. Trendelenburg. [3] T. Bryant; T. R. Pooley.
[4] A. E. Durham. [5] C. Sédillot. [6] F. Trendelenburg.

breadth from it 1 (Fig. 352); the wall of the abdomen was divided in the same direction as far as the peritoneum, and the left rectus at the same time cut partly through; all the vessels were then carefully tied, and after the bleeding had entirely stopped, the peritoneum was divided in the same direction; the edge of the left lobe of the liver was then exposed to view, rising and falling with the respiration, and also a piece of intestine, which might have belonged either to the colon or to the stomach; the peculiar construction of the arteria and vena gastro-epiploica made the junction of the diaphragm at the stomach so characteristic that all doubt disappeared as soon as these vessels were exposed to view; the stomach had shrunk together and attached itself to the vertebral column; its front side was now grasped at a point corresponding best with the incision, drawn somewhat forward out of the opening, and fixed temporarily in the opening by two acupuncture needles stuck through it transversely; the two needles rested crosswise on the outer surface of the abdomen (Fig. 353); in order that

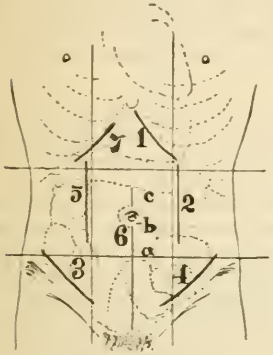


FIG. 352.

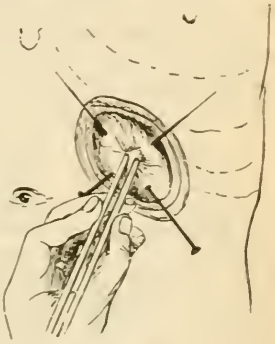


FIG. 353.

the peritoneum should with certainty be included in the sewing up, the edge of it, where cut, was grasped with pincettes and drawn forward and secured by laying the pincettes over on one side; for the stitching, moderately strong silk was used, and the stitches were so arranged that the outer skin, the wall of the abdomen, and the peritoneum were pierced, and the wall of the stomach taken up as much as possible in its entire thickness; fourteen stitches were made; after the sewing, which surrounded a piece of the stomach wall in the form of a circle about five eighths of an inch in diameter, was completed, the stomach wall was cut through within this circle crosswise, and a drain-pipe inserted in the stomach, which was found to be perfectly empty: the whole operation was conducted under antiseptic precautions.[1]

The temporary securing of the front part of the stomach-wall in the incision by means of acupuncture needles stuck through crosswise and resting flat on the outside of the abdomen, is to be recommended, also the bringing forward the cut edge of the peritoneum by means of pincettes; the difficulty of finding the stomach with so small an opening in the abdomen deserves some consideration, for the mistake has been made of sewing up the colon instead of the stomach. The diaphragm and the vena gastro-epiploica, which is seen more distinctly than the artery, will always be the safest guides. It is not desirable to

[1] W. Thomsen.

make the fistula larger than is absolutely necessary for the purpose of fixing a drain-pipe of about five sixteenths of an inch; there is not much gained for the nourishment by a large opening, for in the normal method of feeding through the œsophagus the food does not reach the stomach in unbroken bites, but in a state of coarse pulp, and the attempt to surpass nature in this respect cannot be conducive of very beneficial results. Apart from this, a large opening has great disadvantages. It necessitates having a special apparatus for closing the entrance, where, as with a small fistula, it is only necessary to put in a suitable drain-pipe and cork it up from the outside, to close the stomach entirely. This kind of stopping is perfectly water-tight,[1] because the somewhat swollen mucous membrane of the stomach sets itself close against the drain-pipe.[2]

The after-treatment requires careful management of the wound and diet; the stitches were removed on the third and fourth days; the food was introduced into the stomach by means of a syringe, and consisted of meat parings, soft boiled eggs, and milk. The final arrangement for taking food is through a long tube fastened to a drain pipe in the fistula (Fig. 354).

In feeding, the œsophagus is removed to the outside, otherwise the process is as much as possible like the natural one: the boy tastes his food as before; the masticated and salivated matter remains partly in his mouth and is partly swallowed down into the œsophagus, after which he places the tube in his mouth, and sends the food by a slight choking and spitting motion, into the tube, and lets it glide down into the stomach, assisting it by blowing slightly with the mouth; then he shuts the pinchcock, which he had previously opened, and recommences the process afresh. In this manner he is made independent; he runs and jumps almost the whole day with the drain-pipe in the fistula without a trace of the contents of the stomach flowing out; the neighborhood of the fistula remains dry.

Fig. 354.

Or, make a curvilinear incision with the convexity towards the median line, from the sternal extremity of the seventh intercostal downwards and outwards for nearly four inches. Exposing the sheath of the rectus muscle, slit it up and separate the fibres of the muscle with the fingers and scalpel, the cutting edge being used as little as possible, to avoid hæmorrhage; divide the posterior lamella of the sheath of the rectus, the transversalis fascia, and the peritoneum, successively, on the director; the stomach will now appear projecting beneath the margin of the liver; seize the stomach with forceps having fine strong teeth, and pass a curved needle, armed with strong silver wire, through its anterior wall in the direction of the vertical line of the body, the points of entry and exit of the needle being about

[1] L. Verneuil. [2] F. Trendelenburg.

an inch and a quarter apart; now pass two other needles armed in the same manner from left to right, and make them cross the first at right angles (Fig. 355); the wires thus include the part to be opened, which will be at a point about two inches to the left of the pylorus; withdraw the first wire, and with scissors open the stomach in a perpendicular direction to the extent of an inch, exposing the wires (Fig. 356); divide them and convert the wires into sutures (Fig. 357); after the stomach is opened, make constant traction upon it to prevent

FIG. 355.

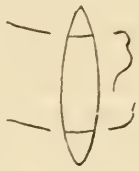


FIG. 356.

FIG. 357.

the escape of its contents into the abdominal cavity; now attach by numerous silver sutures the edges of the viscus to the opening in the abdominal walls so as to secure the most accurate approximation; introduce a tube with a single flange, resting upon the edges of the external wound, and confined by means of tapes passed around the body; close the remaining wound in the abdominal parieties by ordinary sutures.[1]

Other methods: the incision may be crucial;[2] or it may be over the left semilunaris, and the stomach entered near the greater curvature;[3] or make the incision about two inches in length along the outer edge of the rectus muscle in the left hypochondriac region, commencing at the cartilages and opposite the space between the seventh and eighth ribs;[4] or begin the incision at the inner border of the ninth rib, and carry it vertically downward;[5] or, make the incision from the extremity of the seventh rib, vertically downward, about three inches along the margin of the rectus muscle. The coats of the stomach are seized with forceps, drawn into the wound, and opened about three fourths of an inch with scissors.[6] The quill suture has been used to unite the wound of the stomach to that of the skin; to do this, first pass the needles that have already traversed the stomach, and are still armed, through one side of the wound, and with a second needle draw the free ends of the ligature, when threaded, through the other; there will then be two double ligatures through each side of the opening in the stomach and the margin of the wound; tie the two ends over two pieces of bougie, one introduced against the inner surface of the stomach, and the other upon the integument, the bougies admirably compressing the thin walls of the integuments and retaining them there.[7] In general, after the operation, food

[1] F. F. Maury. [2] C. Sedillot. [3] A. E. Durham. [4] C. Foster. [5] S. Jones.
[6] T. B. Curling. [7] T. Bryant.

should not be given by the stomach for a few hours, nourishment being maintained by the rectum.

4. **Wound of the stomach** is recognized by its position, its depth, and its special direction, the escape of food or drink, vomiting of blood, pain and faintness, with pallor, cold extremities, small and frequent pulse, thirst, singultus, and tympanitis; if the organ is empty there will be no extravasation, and the amount of hæmorrhage will depend upon the extent to which the curvatures and extremities, where the arteries are located, are involved. Ocular inspection, when possible, and the introduction of the educated finger into the wound, give the only positive evidence of these lesions of the stomach.[1] These wounds must be carefully closed by suture.[2] Gastroraphy, or suture of the stomach, should be so performed as to secure the inversion and approximation of the serous surfaces.[1] If the wound is a mere puncture, pinch up the lips of the opening and include it in a ligature; in small wounds, whatever their direction, make the interrupted suture with a fine cambric needle, and armed with a small but strong and well-waxed thread; pass the needle from one side of the wound to the other, across all the tunics of the bowel except the mucous, in such a manner as to bring the serous edges in the most accurate apposition; place the sutures about two lines apart, and introduce the entire number before any are tied (Fig. 360); secure the ends with double knots, and cut off close, so that as the sutures become detached they will fall into the cavity of the stomach; when the wound is of unusual length select the continued suture (Fig. 358); each stitch including not more than half a line of substance; the ends of the thread being well secured at each angle of the opening should be cut close to the surface of the tube.[2] Accessible shot wounds of the anterior wall should be treated by suture, but the bruised edges should not be refreshed, for as the loss of substance is confined to the muscular, connective, and mucous tissue, the serous membrane remains sufficiently organized to hold stitches; what sloughing there may be from the inner tunics will fall into the cavity of the stomach; cut the ends of the sutures short, and return the whole within the cavity of the abdomen.[1]

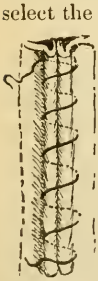


FIG. 358.

Take a short stitch on one side of the wound, about two lines and a half from the edge, including only the peritoneal and muscular coats, then carry the needle across the gap and take a similar stitch on the opposite side; repeat the stitches, the interval not exceeding the sixth of an inch; when they are all arranged, draw them firmly together, tie with a double knot and cut off the ends; the wound is thus completely closed in every portion of its extent; its lips being inverted, approximate their serous surfaces[3] (Figs. 359, 360). Or, arm a

[1] G. A. Otis. [2] S. D. Gross. [3] M. Lembert; S. D. Gross.

waxed thread at either end with a small glover's needle; introduce one parallel to the wound without and back of one of its angles about one line, and bring it out on the peritoneal surface after traversing the bowel for about the sixth of an inch; practice the same upon the opposite side with the second needle; cross the threads, and pass the right needle through the puncture made by the left, and conversely; repeat the stitch as often as may be necessary to completely close the wound; tighten the threads by taking each successively at the transverse points with dissecting forceps, and make suitable traction, at the same time depressing the lips of the wound; tie the threads, and cut them close; the approximation is so complete that no trace of the threads or knot appear externally.[1] (Figs. 361, 362, 363, and 365).

FIG. 359.

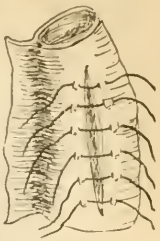


FIG. 360.

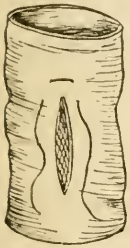


FIG. 361.

FIG. 362.

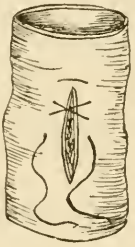


FIG. 363.

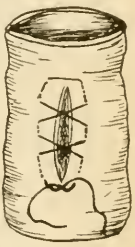


FIG. 364.

The after-treatment consists in administering, for a few days, ice in quantities to allay thirst and quiet irritability; after that a little arrowroot, tapioca, sago; if gastroraphy has been neglected, or is impracticable, withhold everything by the mouth until the edges of the wound have contracted adhesion to the adjacent parts, and rely upon the application of ice to the epigastrium, nourishing enemata, and morphia to relieve pain.[2]

6. **Foreign bodies** are often introduced into the stomach accidentally or intentionally, and unless removed may create fatal inflammation and ulceration; they may remain in the stomach for a certain period without much inconvenience, but sooner or later they produce serious consequences; if the substance be a piece of money, or any other small body, it will be passed off, often without much discomfort, in the course of a few days, sometimes within forty-eight hours of having been swallowed; but should the substance be a bone or other irregular-shaped or uneven mass, it may be some weeks before it escapes through the rectum. The early symptoms of a foreign body in the stomach will depend very much on the shape and nature of

[1] M. Gély; G. A. Otis. [2] S. D. Gross.

the mass; a pin, or sharp bone, or pointed instrument, will cause pain in the epigastrium, often of a severe character, a sense of weight and discomfort at the stomach, a desire to vomit, or an ejection of the contents of the stomach with blood; if the person is thin and the substance large, it may occasionally be detected, through the abdominal walls. A sharp-pointed mass may gradually penetrate the walls of the stomach and ultimately escape externally; needles and pins may escape through various structures and make their exit at some distance from the point at which they escaped from the stomach. The treatment must depend upon the nature and shape of the substance; pieces of money and many other bodies are aided in their passage by bulky ingesta, and hence it is better to avoid purgatives, and rather allow food plentifully in order to have the foreign body embedded in and surrounded by feculent matter. If the body is retained in the stomach and life becomes endangered by its presence, the stomach should be opened and the foreign body removed. Gastrotomy, section of the stomach, for the removal of foreign bodies, has proved an entirely feasible and successful operation; the method of procedure is in detail the same as gastrostomy, but the wound must be closed by sutures.

CHAPTER XXXVI.

THE DUODENUM; THE JEJUNUM; THE ILEUM.

I. THE DUODENUM.

This is the shortest and widest part of the small intestine, varying in diameter between an inch and a half and two inches, and is ten to twelve inches in length.

It has no mesentery, and is only partially covered by the peritoneum; in its course it describes a single large curve, the convexity towards the right and the concavity embracing the head of the pancreas, and passing from the pylorus to the under surface of the liver, thence downward in front of the right kidney as low as the second or third lumbar vertebra, where the bowel turns across to the left, and ascends obliquely for an inch or more.[1]

1. **Foreign bodies** may enter the duodenum from the stomach, or from the liver and gall bladder. Of the former, are masses of pins, collections of hair and threads, and of husks of grains, as well as large bodies, like spoon-handles, knives. Of the latter, are biliary calculi, which, if small, pass readily through the bowel, but, if large, may enter it by ulceration, and form a permanent obstruction. The symptoms are those of gastric and hepatic derangement, until the ob-

[1] Quain's Anatomy.

struction becomes considerable; then the tumor may be perceptible; the vomiting is persistent, but never stercoraceous. No operative interference has been undertaken.

2. **Wounds** of the duodenum, generally fatal, involve other important structures; as the descending and middle portions have no proper peritoneal coat, but are loosely fixed between the laminæ of the meso-colon, this part may be wounded without extravasation of its contents into the great peritoneal cavity.[1] The treatment must be on general principles, as no operation has been devised.

II. THE JEJUNUM AND ILEUM.

The jejunum commences on the left side of the second lumbar vertebra; it is attached and supported by the mesentery and its convolutions are in the umbilical and left iliac regions; the ileum is continuous with the jejunum, and its convolutions occupy part of the umbilical, right iliac, hypogastric, and pelvic regions, and from the latter it ascends to the right iliac fossa, where it ends in the cæcum.[2]

1. **Wounds of the jejunum and ileum** from penetrating instruments are frequent, owing to the great length of these bowels, their floating condition, and the large space over which they are spread. In general, the wounds are oblique, but occasionally they are transverse, and sometimes, though rarely, longitudinal; they vary also from the smallest puncture to lesions inches in length, or even to complete division of the tube.[3] The danger is in proportion to the liability to extravasation of the contents of the bowel, and this depends upon the extent and nature of the wound. If the wound, whatever its direction, does not exceed four lines in length, or a third of an inch, nature, aided by appropriate therapeutic measures, will, in many, if not in a majority of cases, be fully competent to effect a cure; but when the opening is six lines in extent, whether transverse, oblique, or longitudinal, there is almost invariably an escape of fæcal matter, followed by fatal peritonitis.[3] In punctured wounds the opening is contracted by the circular and longitudinal fibres and closed by the eversion of the mucous lining; in transverse wounds, there is slight gaping from the contraction of the longitudinal fibres, but the calibre is diminished by the contraction of the circular muscular layer, and the pouting of the mucous membrane impedes the escape of fæcal matters; in complete transverse section of the gut, the divided extremities are so separated and puckered as to render it difficult to distinguish the upper from the lower portion, except by the escape of fæces; in large longitudinal wounds, the contraction of the circular muscular fibres causes

[1] G. A. Otis. [2] Quain's Anat. [3] S. D. Gross.

wide gaping of the edges, and permits the escape of the contents of the bowel.[1] The most important immediate symptoms of lesion of the bowels are, shock, pallor, nausea, small and tremulous pulse, sudden tympanitis; secondary symptoms are, discharge of blood from the anus, pain in the abdomen, dull and aching or sharp and colicky, tenderness, posture so as to relieve pressure.[2] But the diagnosis is positive only when the bowel protrudes from the external wound and can be inspected, or when there is an escape of the contents of the bowel externally. If the bowel cannot be examined, it is well to ascertain, first, the position of the parietes at the time of the accident, the size and shape of the instrument; then, if the opening in the wall of the abdomen is large, place the part and body as nearly as possible in the position they were when the injury was inflicted, and, avoiding all officious interference, carefully explore with the index finger, aseptic, or a director, to determine whether the wound involve the muscles only or the muscles and peritoneal cavity.[2] The treatment of all punctured and incised wounds of the intestines, attended with protrusion, consists in closing the intestinal wound by suture, and reducing the protruded viscus, unless its structure is irretrievably disorganized, and the adoption of the alternative of establishing an artificial anus is compulsory;[1] even if the wound is not more than a line and a half in length, the bowel ought not to be returned without the suture, lest fæcal extravasation occur.[2] As the suture is intended to prevent extravasation, there must be the most perfect adaptation of the edges of the wounded intestine; when finished, the threads must be cut close to the knot, and the bowel returned to its natural bed, without any measures being taken to retain the wounded portion near the external wound; on the replacement of the bowel the latter must be treated as if no other injury had occurred.[3] In wounds of the intestines, unattended by protrusion, if there is danger of extravasation, the external wound should be enlarged, and the wound in the intestine closed by a proper suture.[4] Enteroraphy, suture of the bowel, in itself one of the most innocent of operations, is best accomplished by the common interrupted suture, which, judiciously employed, gives excellent results, whatever may be the situation, direction, or extent of the wound.[4] The operations described for wounds of the stomach may be performed in wounds of the intestine. An indispensable element in the treatment of these wounds is the constant and intelligent use of antiseptics.

If the wound involve the entire circumference, proceed as follows: determine which is the upper end of the gut; dissect away the mesentery a third of an inch from each end and arrest the bleeding that ensues; then, holding the upper extremity by the left hand, with the right insert a stitch through it two thirds of

[1] G. A. Otis. [2] S. D. Gross. [3] G. Pollock. [4] G. A. Otis; S. D. Gross.

an inch from the divided margin (Fig. 365) and give the loop into the hands of an assistant; introduce a second stitch in like manner at the opposite or mesenteric side of the bowel; then with the fingers, or with flat forceps, invert the lips of the lower portion, which is a difficult procedure; when accomplished, maintain the inverted hem between the left index finger introduced, and the thumb, and along the finger, as a guide, introduce the inner end of the first loop inserted in the upper portion of the bowel, and in like manner the second; by gentle traction upon the two loops, invaginate the upper portion within the lower (Fig. 366); the loops may now be tightened and knotted or twisted, or the hem may be traversed by the outer ends of the two loops (Fig. 367) and the stitch then tightened and secured by torsion or by knot; bring the ends of the ligature out at the lower angle of the external wound; withdraw the threads on the fourth or fifth day by gentle traction.[1]

Fig. 365.

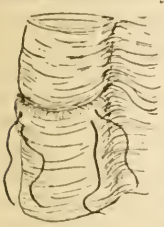


Fig. 366.

Fig. 367.

2. **Gunshot wounds** of the small intestines are severe in proportion to the size of the ball; large projectiles generally cause hopeless evisceration; musket-balls commonly partially or completely divide the calibre of the small bowel; pistol or carbine balls often make single or twin perforations.

Shot injuries of the duodenum are commonly accompanied with mortal lesions of adjacent parts; the jejunum is very liable to perforation by shot, and these wounds are often complicated by lesions of the adjacent viscera or of the mesenteric arteries, but there is not immediate extravasation owing to the emptiness of the bowel; the ileum, though somewhat protected posteriorly and laterally, is fully exposed in the umbilical, hypogastric, and right iliac regions.[2]

The treatment of shot injuries of the small bowel which protrudes is by enteroraphy, as in incised wounds. If the bowel do not protrude, the rule of practice is still non-interference.[3] If the wounded intestine becomes attached to the external wound an artificial anus is formed and the contents of the bowel are discharged external at this opening. It becomes a matter now of great importance to restore the passage by the removal of the septum, or the two apposed walls of the intestine.

There is a growing conviction that the time has come when gun-shot and other wounds of the abdomen, and perforations of the intestines should be treated by opening the peritoneal cavity and washing out or draining off the septic fluids that would otherwise poison the blood,[4] and this practice is rendered the more safe and feasible by the use of disinfecting spray during the whole operation.

[1] Jobert de Lamballe; G. A. Otis.
[2] G. A. Otis.
[3] S. D. Gross; Neudorfer; F. H. Hamilton.
[4] J. M. Sims; G. A. Otis.

If the septum is slight, dilate both ends of the intestine by means of lint tents, regularly increased in size and retained by compress, and follow by introducing conical plugs into the external opening, thus forcing the septum back towards the abdomen, and leaving the two ends of the intestine opposite each other; continue treatment until fæces pass freely from the upper to the lower bowel; subsequent compression with a pad and truss is in many cases followed by complete cicatrization.[1] If the septum is prominent and unyielding, it must be destroyed by the enterotome, selected and applied thus: Select an instrument with serrated edges worked by a screw (Fig. 368); place the patient on the back and distinguish the upper and lower ends of the bowel; now take one branch of the enterotome in the right hand and pass it carefully along the track of the bowel one to three inches, according to the depth of the septum; while an assistant retains this branch, introduce the other with the same care along the other bowel; now join the blades and tighten them sufficiently to compress the opposed serous surfaces firmly together, and finally to destroy the septum by strangulation (Fig. 369); after a few days the instrument becomes loose and finally falls; the after treatment requires compress and truss until the wound heals.[2]

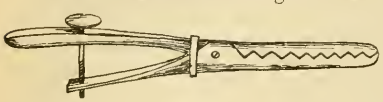


Fig. 368.

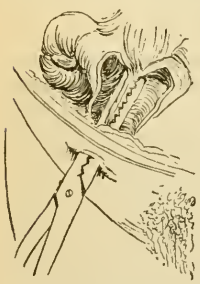


Fig. 369.

Other methods, are the ligature[3] passed through the septum and frequently tightened until firm adhesions have taken place between the opposed serous surfaces, and then division of the remainder by the bistoury; destruction of the septum by caustic,[4] and by excision;[5] suture of the margins of the wound in the abdominal wall;[6] anaplasty.[2]

3. **Intussusception of the jejunum and ileum** is most frequent in adults, at the average age of thirty-four;[8] but it may occur in the infant.[9] Owing to the comparative narrowness of the tube into which the invaginated portion of the bowel descends, strangulation and congestion are speedy and intense, and sloughing and separation of the strangulated part are consequently most frequent.[10] It follows that this invagination generally runs an acute course; impermeability is immediate and permanent, and death may follow in from three to six days, with or without peritonitis or perforation; in other cases the invaginated portion sloughs, either in strips and shreds, or in tubular sections, between the eleventh and twenty-first day.[11] The gen-

[1] Desault. [2] Dupuytren. [3] P. S. Physick. [4] Vidal. [5] Rayé. [6] LeCat. [7] Collier. [8] W. Brinton. [9] J. L. Smith. [10] J. S. Bristowe. [11] O. Leichtenstern.

eral symptoms of intussusception combine a variable degree of obstruction and inflammation: the patient is seized with a sudden, violent pain, often exactly localized in the region corresponding to the intussusception, and, even when most agonizing, sometimes distinctly recognized as a straining or tearing sensation, rarely accompanied by rigors; vomiting follows, which may subside if the inflammation is early and intense, but more frequently continues and becomes stercoraceous in the course of three or four days. The tumor caused by the intussusception is a physical sign of the greatest value; though of small size in many cases, especially in the earlier stages, and often obscured by the distention of the intestine, yet a careful examination will usually detect its presence.

The chief distinction of intussusception from all other varieties of obstruction is the suddenness of the invasion, the acuteness of the pain, the rapidity of the prostrating effect, and, above all, the detection of the intussusception itself.[1]

The most characteristic features of intussusception of the small intines are the violence of the symptoms, the rapid progress of the disease, more copious hæmorrhage from the bowels, blood sometimes in the vomited matters, more complete obstruction, the discharges containing little or no fæcal matters, the absence of tenesmus, the tumor small and situated within the abdomen and often in the hypogastrium. The indications of treatment are: (1) the use of enemata to move the bowels, emetics and purgatives being avoided; (2) the administration of opium to alleviate pain, quiet the intestines, prevent the increase of invagination, and favor both the reduction of the swelling and the restoration of the passage; with children, it must be given in small quantities and with great care, but for adults it must be used watchfully in powerful doses;[2] hypodermic injections of morphia are generally to be preferred. The question of reducing the invagination demands early consideration, and must be determined with due regard to the fatality of the disease, the possibility of recovering in each individual case, with or without sloughing of the invaginated portion, and the fact that rough, forcible, ill-timed proceedings will do more harm than good.[2] The value of the various methods may be estimated as follows: (1) Crude mercury, like drastic purgatives, should never be administered with a view to force a passage. (2) Injections of air and fluids are of doubtful value, for they rarely, if ever pass the ileo-cæcal valve from the colon to the ileum unless the ileo-cæcal sphincter is relaxed by opium or anæsthetics.[2] (3) Puncture of the intestine with an aspirating needle may be made to withdraw accumulated gases; if carefully performed with a fine, disinfected needle, the operation is quite without danger, and gives immediate though temporary relief;[2] for the operation, select the

[1] W. Brinton. [2] O. Leichtenstern.

smallest aspirating needle and employ the aspirator, in order to create powerful suction; if the pump is not accessible, the common bulb syringe[1] may be attached and will generally prove efficient; dip the needle in boiling water or a disinfectant solution; insert the needle, by a slight rotary motion, into the most prominent and resonant point of the abdomen and pump out all of the gas; withdraw the needle instantly while working the pump in order that no matters contained lodge in the cellular tissue; a small trocar and canula may be used, but they are not as efficient as the needle and aspirator.[2] Laparatomy, abdominal section, is performed for the purpose of exposing the intussusception and reducing it by manipulation; the operation has received but limited sanction from surgical authorities, but is evidently growing in favor, especially when combined with disinfection of the air by means of carbolized spray. It may be undertaken at the earliest age, having proved successful in the infant of six months; but it is important that it should be performed as early as practicable, for success depends largely upon the condition of the bowel; and when the strangulation is tight, the parts speedily become so altered by swelling, adhesion, and softening, that no amount of force short of that liable to cause rupture, will suffice to liberate them.[3] Operate as follows: The patient being fully under the influence of an anæsthetic, and the atomizer, if used, in operation, make an incision two or three inches in length in the median line, commencing just below the umbilicus, *a* 6 (Fig. 352); on exposing the peritoneum, open it cautiously at the upper angle and introduce two fingers previously treated with carbolic solution; enlarge the opening to the required extent; with the same fingers explore the bowels, and when the intussusception is discovered, withdraw it sufficiently to render manipulation easy; effect disinvagination by gentle traction upon the two portions, or by pulling the ensheathing layer downward and squeezing the lower end of the intussuscepted gut.[3] When the reduction is effected, gently replace the escaped bowels, an act often requiring great patience and tact, and close the wound with silver sutures, including the peritoneum; support the walls of the abdomen by adhesive plasters and bandages.

5. **Strangulation of the small intestines** may be caused by peritoneal false ligaments, by the omentum and mesentery, by slits and holes in different organs, by diverticula, by the appendix vermiformis, by internal hernia, and by twisting, knotting, and compression.[4] In occlusion of the jejunum, collapse, vomiting, and anuria usually appear early and soon reach a considerable height; the course is usually rapid, the meteorism inconsiderable, limited to the epigas-

[1] Davidson. [2] J. G. Blake; H. J. Bigelow. [3] H. B. Sands.
[4] O. Leichtenstern.

trium, or entirely wanting, and the abdominal wall even retracted; the vomited matter is stained with bile, greatly discolored, but never feculent; when the occlusion is of the lower part of the ileum, the meteorism is noteworthy, sometimes limited mainly to the meso- and hypogastrium, with comparative hollowness of the regions corresponding to the colon; the course is also rapid, collapse, vomiting, and suppression of urine appearing early, but the vomited matters soon become feculent.[1] In the treatment, (1) relieve the pain by full doses of opium; (2) attempt to reduce the strangulation by kneading the abdomen while the patient is in a bath, with the legs drawn up, or under an anæsthetic; (3) perform laparotomy, find the cause of the strangulation, and divide bands or strictures; (4) if the bowel is gangrenous, or obstructed beyond relief, add enterotomy and establish an artificial anus.

6. **Obstruction of the jejunum and ileum** may occur from intestinal and gall stones and foreign bodies swallowed; they lodge most frequently in the lowest part of the ileum, one or two inches above the ileocæcal valve, owing to the diminution of the calibre of the intestine as it approaches the cæcum, and its fixation by a short mesentery.[1] Intestinal stones, enteroliths, rarely occlude the bowel suddenly, but give rise to premonitory symptoms, as emaciations, hypochondria, sometimes signs of diminished permeability, or typhlitis; often a tumor may be felt in severe cases, and as the patient may have a cachectic appearance, causing suspicion of cancer.[1] Gall stones may occlude the ileum suddenly, after severe hepatic colic, followed by meteorism, at first limited to the hypo- and meso-gastrium, with vomiting, which becomes feculent; or the occlusion may be preceded for a long time by symptoms of diminished permeability, and repeated but temporary symptoms of total obstruction.[1] When a foreign body has passed through the pylorus, it has to traverse the horseshoe coil of the duodenum, producing most intense agony when the substance is of an elongated form; it is liable to be arrested here, but in most instances passes outward, and there is then nothing to obstruct it until it reaches near the ileo-cæcal valve; but it may become arrested in any part of its course along the small bowels. The symptoms induced are very vague and uncertain, and give no evidence of either the presence or situation of the foreign body; they may consist of those of acute and chronic enteritis, cæcitis, and colitis, and even peritonitis.[2] Ordinarily they excite symptoms of partial obstruction, and may give rise to a constriction by cicatricial bands or chronic peritonitis.[1] If the obstruction is acute, administer opium at once, and in full doses; if chronic, and the symptoms of increasing obstruction of the passage grow more severe,

[1] O. Leichtenstern. [2] A. Poland.

give doses of castor oil, or calomel, and enemata of cold water.[1] Gentle but persistent rubbing and kneading of the bowels, with change of position, has frequently proved successful in dislodging the obstruction and even overcoming an intussusception.[2] Operative interference is justified only when three or four days have passed without any relief from ordinary means, the constipation being complete, and vomiting of fæcal matter continuing, because it affords a greater chance for the preservation of life than the ordinary means;[3] laparotomy should then be unhesitatingly performed,[4] for many cases of intestinal obstruction undoubtedly prove fatal, which, by timely operative interference, would result favorably.[5] If the obstruction is not defined, the opening may be made in the right groin[6] by an incision in the course of Poupart's ligament, 3 (Fig. 352); the peritoneum being opened, draw the lower portion of the ileum into the wound and attach it to the margins of the skin by wire sutures and open it between them; there is a possibility that the obstruction will in time be relieved through this artificial anus.

CHAPTER XXXVII.

THE CÆCUM; THE COLON.

I. THE CÆCUM.

The cæcum is the most capacious portion of the large intestines, being about two and a half inches in length and breadth.

It consists of a large pouch, occupying the right iliac region, where it is retained in position by a fold of peritoneum reflected in front, and by an attachment of loose connective tissue, though the peritoneum, by doubling posteriorly, sometimes renders the cæcum less fixed than ordinarily; the lower extremity curves inwardly and backwards, and is abruptly reduced into a worm-like prolongation, the vermiform appendix, four or five inches long, thick as a goose quill, of narrow calibre, usually somewhat coiled and retained by a fold of peritoneum.[7]

1. **Wounds** of the cæcum are frequently recovered from, even when projectiles pass directly through its cavity. This comparative immunity is due largely to the situation of the cæcum in the lower part of the abdominal cavity, and only partial investment by the peritoneum. The diagnosis depends upon the direction of the weapon or missile, and the discharges from the wound. The treatment is expectant, consisting of rest, anodynes sufficient to relieve pain, cold at first to prevent inflammation, followed by poultices, and if pus forms, evacuation.

[1] O. Leichtenstern. [2] J. Hutchinson. [3] A. Poland [4] J. Ashurst, Jr.
[5] J. Hilton. [6] E. Nélaton. [7] J. Leidy

2. **Perforation of the appendix vermiformis**[1] frequently follows the lodgment of foreign bodies in this tube, as grape-seeds, or even concrete mucus: the perforation may allow the body to escape directly into the peritoneal cavity, when fatal collapse immediately ensues; more frequently inflammation is set up, which results in the formation of an abscess.

This abscess may terminate as follows: (1) in a dried mass of semi-calcareous product; (2) the adhesions may suddenly break down and fatal extravasation into the peritoneal cavity follows; (3) it may open into the intestine and discharge; (4) it may penetrate the cellular tissue behind the cæcum, and pass upward behind the colon, or downwards towards Poupart's ligament, where it may find an opening at the anterior superior process or under the ligament; the perforation sometimes takes place directly.

The symptoms[2] depend upon the varying conditions of its progress, but in general the formation of an abscess would be indicated by the following signs: after some irregularity of the bowels, either diarrhœa or constipation, generally the latter, and perhaps after more than wonted exertion, severe pain comes on, in many cases suddenly, in the right iliac fossa; the pain may be confined to this spot, and be accompanied by excessive tenderness, radiating over the abdomen, and be very quickly followed by collapse, and signs of general peritonitis, as, extremely anxious countenance, sunken eye, cold extremities, distended and tympanitic abdomen, clammy, partial sweats, failing pulse, and death in a few hours; or the tenderness and pain in the neighborhood of the cæcum are accompanied with fullness, and slight dullness in percussion; the skin is hot, the tongue slightly furred, pulse often compressible and somewhat excited; local peritonitis is set up in connection with ulceration or inflammation of the coats of the cæcum. Exploration by the rectum sometimes enables the finger to detect the tumor, and determine its location.

Resolution may now occur with gradual subsidence of all the symptoms, or the fullness, tenderness, and pain may continue, and a more defined tumor become perceptible, which may at any time perforate the peritoneum and prove fatal, or open into the intestine, or may gradually distend the iliac fossa and approach the surface.

The treatment must be perfect quiet, castor oil to remove irritating matters from the bowels, followed by opium to relieve pain, and poultices to the tumor to hasten the process of the formation of thick abscess walls and bring pus to the surface. The abscess must be opened as soon as pus is detected, and as early as the eighth day if pus is not detected, and the disease has steadily progressed up to that time;[3] longer delay is dangerous, and at this period the abscess walls have commonly caused firm adhesions of the peritoneum.

[1] S. O. Habershon; G. Lewis. [2] G. Lewis; S. O. Habershon. [3] W. Parker.

It is safe always to explore, when there is a doubt, with the finest aspirating needle, or the hypodermic syringe; if pus is discovered, the abscess may be opened by the sharp-pointed bistoury entered at the place of exploration.[1]

The formal operation[2] is as follows: Make an incision five or six inches in length, if the swelling is large and pus has not been detected, commencing an inch internal to and above the anterior superior spinous process and extending towards the pubes 3 (Fig. 352); continue the dissection through the several layers of the abdominal wall; raising them cautiously, and with a director, if necessary until the abscess wall is reached; introduce an exploring needle, and if pus is found, puncture the abscess. If, after dissecting down to the peritoneum, pus is not formed, the wound may be left open and the abscess will subsequently discharge through this wound. The abscess should be cleansed twice daily with carbolized water,[3] and the wound should be allowed to heal by granulations. It may be necessary to apply a truss for some time, owing to a tendency in some cases to hernia.[3]

3. **Cæcal abscess**[4] may result from the extension of inflammation of its internal coat or by the ulceration and perforation of the walls.

In consequence of the angular course which the axis of the intestines takes at this point, the cæcum acts as a natural resting-place for the food as it passes through the intestinal canal; normally composed fæces may be here retained sufficiently long to become hardened, or even converted into true fæcal calculi; these masses and indigestible substances, swallowed in the food, such as kernels of grain, pins, pieces of bone, may collect in the cæcum, where they act as irritants to the mucous membrane and excite inflammation, and ultimately produce ulceration so deeply as to perforate the bowel.

If the ulceration is rapid, extravasation may take place, followed by fatal peritonitis. The attack occurs suddenly, without premonitory symptoms, or may be preceded by constipation, dull pain in the abdomen, colic, and other symptoms of derangement; the immediate attack is ushered in by severe pain, limited to the right side of the abdomen, increased by motion, even in breathing, and aggravated to its greatest intensity by pressure upon the right inguinal region; palpation reveals a tumor, composed partly of impacted fæces, and partly of inflammatory exudation; the percussion note is dull, or at least, dull tympanitic, and the movements of the right thigh are painful. The patient frequently becomes typhoid, and the disease is often mistaken for typhoid fever. The treatment should be rest, castor oil to remove all irritating matters from the cæcum, then opium to relieve pain and restlessness, and poultices to hasten the approach of the pus to the surface; the swelling should be explored with a fine aspirating needle, or common grooved needle, or hypodermic

[1] G. Buck. [2] H. Hancock; W. Parker. [3] L. Weber. [4] W. Leube.

syringe; if pus is found, open the abscess with a sharp-pointed bistoury, at that point, or by free incision. If the swelling fill the iliac fossa, and no pus is found, operate as in abscess of the appendix, and if pus is still not found, keep the wound open to favor the escape of pus when it is formed.

4. **Intussusception** assumes two principal forms in this region; (1) ileo-colic, the passage of the ileum through the ileo-cæcal valve; (2) ileo-cæcal, the passage of the ileum and cæcum into the colon; the former is very rare, the latter the most common, especially in childhood and during the first year.[1]

These invaginations more often run a chronic course, and are distinguished from those of the small intestines by the prominence of tenesmus, which is rarely present in any marked degree where the small intestine only is implicated; by the greater size and fixation, and different site of the sausage-like tumor, which, if large, generally occupies the left side of the hypogastric or left iliac region; by the hæmorrhage, which, instead of being copious, is often little more than a scanty admixture scarcely sufficient to tinge the mucus passed from the bowels with violent and frequent straining; by the degree of obstruction which seems to be really absent owing to the patulous state of the axis of invagination; by the presence in the more marked and protracted cases of the invagination in the rectum.[2]

The tumor is rarely discovered in the region of the cæcum, owing to its small size, want of firmness, and its rapid progress along the colon, rendered easy by the great mobility of the cæcum; nor is it easily detected when it occupies either colic flexure, particularly the right, where it will be overlaid by the liver; more often it is found along the course of the descending colon, as an elongated swelling somewhat movable from side to side, frequently becoming harder and more prominent during a paroxysm of pain; the finger in the rectum may detect the tumor and define the ileo-cæcal valve, and if the other hand meantime is applied to the abdomen, the continuity of the rectal and abdominal tumor may be determined.[3]

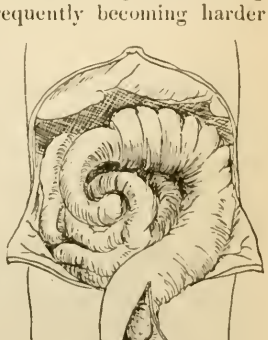


FIG. 370.

The post-mortem appearances[4] of fatal ileo-cæcal intussusception were as follows (Fig. 370): the descending colon was enormously enlarged and full; the sigmoid flexure was distended and made a great curve nearly to the right side of the abdomen; the distended transverse colon, thrown into transverse folds, could be traced to the right side of the median line; the ileum, cæcum, and ascending colon were entirely intruded, and pushed into the descending colon, descending into the rectum within a few

[1] O. Leichtenstern. [2] W. Brinton. [3] H. B. Sands. [4] S. O. Habershon.

inches of the anus; on opening the rectum and sigmoid flexure, the termination of the intussuscepted portion was found to be almost black, the apex very tense and its opening marked by a fissure caused by the contraction of the mesentery; turning aside the bowel, it was found to be convex and twisted, from the dragging of the mesentery, and at the concave side was a large irregular ulcer at the most tense portion; there was general peritonitis, due to perforation of an ulcer in the sigmoid flexure.

The treatment is the same as ileum invagination, to which is added injections of air and water. The distention of the lower bowel must be carried to the fullest extent short of rupture, and should be undertaken early, before adhesions have formed; if water is used, place the patient on the back, in bed, or if a child on the lap of the nurse; elevate the hips 45°, to secure the aid of gravitation; provide lukewarm water, and with the common bulbous syringe, or, better, the fountain syringe, inject it gently until the abdomen is somewhat distended; now carry the finger gently but firmly over the abdominal walls along the direction of the colon, in order to force the liquid upward against the intussusception; if the water is discharged, the injection may be several times repeated.[1] If water fail, inflation may be resorted to, which produces a more equable and effective distention; the common bellows, with a tube, is efficient;[2] or carbonic acid gas may be employed, as obtained from bottles charged with the gas in the shops; by inversion a powerful current may be conducted through the tube of a rubber syringe.[1] The operation of laparotomy, in this form of invagination, should be undertaken as a last resort, but the delay should not be so great as to endanger the integrity of the bowel.

II. THE COLON.

The colon ascends from the cæcum in the right iliac region in front of the right kidney to the under part of the liver, the ascending colon; it then crosses through the upper boundary of the umbilical region to the left hypochondriac region, the transverse colon, where it forms an angle and descends in front of the left kidney to the left iliac region, the descending colon; here it forms an S-like convolution, the sigmoid flexure, and enters the pelvis as the rectum.[3]

1. **Wounds of the large intestine**[4] are less fatal than those of the small, owing to the fact that there is less liability in wounds of this portion of the intestinal canal to extravasation of the fæcal contents into the peritoneal cavity; this is due to the disposition of the muscular coat, and the firm attachments by which the gut is secured, which tend to preserve that parallelism between the wounds in the parietes and in the bowel, and that apposition of the intestinal and

[1] J. L. Smith. [2] D. Greig. [3] J. Leidy. [4] S. D. Gross.

parietal surfaces that are such important safeguards; further favorable conditions are found in the facts that the colon is only partially invested by the peritoneum, and injuries of its ascending and descending portions especially, do not necessarily jeopardize other organs. Those wounds are generally attended by stercoral fistula, which commonly close after a time, without operative interference, reopening at intervals and then healing permanently. The differential diagnosis between wounds of the large and small intestines is often very difficult, and sometimes unattainable. These wounds often do well without interference, and enteroraphy will seldom be requisite unless the wounded colon protrudes; but there are exceptional cases in which extending the external wound and sewing up the rent in the gut is the only means of preventing extravasation.[1]

In a considerable number of these wounds the abnormal communication between the bowel and the exterior of the abdomen remains open, and constitutes an artificial or preternatural anus; but there is an absence, or only slight development of the crescent-shaped septum commonly formed in cases of preternatural anus following mortification of the intestine in strangulated hernia.[1] As the chief obstacle to the permanent closure of abnormal anus is the septum, which prevents the contents of the bowel above from reaching the calibre of the bowel below, these lesions in which the septum is slight, are more curable than those which follow strangulated hernia. The treatment, therefore, depends upon the features of each case; if the opening is small, keep the parts clean, and restrain the escape of fæces or food through the orifice by the application of gentle pressure, and closure will frequently occur; if the wound shows no tendency to close and the patient refuse operative interference, place a compress of linen in the opening with a larger pad over it, and apply a truss to retain dressings.

2. **Simple stricture of the colon**[2] results from the cicatrization after ulceration of the mucous membrane; the stricture may be a mere ring, or it may occupy several inches of the bowel. The symptoms may for a long time be vague, inconclusive, and even misleading; occasionally the symptoms come on quite suddenly, but in general the patient suffers for weeks, or months, or years, with occasional attacks of colicky pain, associated it may be with more or less constipation, or even diarrhœa; when the case is free from complications its progress is essentially chronic; but sooner or later symptoms appear which indicate impassable stricture; namely, insuperable constipation, painful peristalsis coming on periodically, and often rendering itself audible by borborygmi, and visible through the abdominal walls; abdominal fullness and uneasiness, followed by nausea and vomiting, and finally the ejection of stercoraceous matters. It is difficult to determine the seat of stricture, and the only guides are distention of the bowels above and collapse below; thus fullness and dullness in the course of the cæcum and ascending colon indicates

[1] G. A. Otis. [2] J. S. Bristowe.

stricture at the hepatic flexure; the same conditions of the transverse colon point to stricture at the splenic flexure, and the like state of the descending colon locates stricture at the sigmoid flexure.

FIG. 371.

The flexible rubber tube[1] now renders it possible to fully explore the colon as far as the cæcal portion, from the anus, and test its calibre (Fig. 371): different sizes may be used to determine the calibre; the tube must be introduced very gently, but being very yielding, no harm can be done unless unnecessary force is employed.

The treatment is perfectly fluid or pultaceous food, easy of digestion, and well masticated; relief of constipation, by simple non-purgative enemata; avoidance of purgatives. If the stricture is at any point below the splenic flexure, dilatation may be attempted with the rectal dilator and explorer (Fig. 371).[1]

The dilators used are manufactured out of pure rubber, with a canal running the whole length, and gradually increasing in size by an eighth, from a quarter of an inch to an inch in diameter; each dilator is fitted with a gum sheath of corresponding dimensions. The points of the dilators taper for an inch and a half, or two inches, conically; the whole length of the sheath, both inside and outside the bowel, or any portion of it, may be filled with water; in the latter case a thread of silk is to be twisted around the dilator at any point that it may be desirable to limit the distention.

The method of introducing the dilator is as follows: Place the patient, reclining on his left side, upon an ordinary operating-table, the thighs flexed and the buttocks just overhanging the lower edge. The smallest-sized instrument is smeared with grease, and its point inserted into the anus and gently pushed onward in the following manner: the right hand grasps the dilator close to the anus, and the whole perineum is to be pressed upwards, which will advance the point of the instrument; the left hand now steadies it, while the right is slid downwards for a lower hold, the perineum of course settles with it; the dilator is again pushed forward in the same manner until the obstruction is passed; this may be greatly facilitated by sinking the fingers of the left hand deep into the left iliac region, and drawing upwards, as though an effort was being made to stretch out the sigmoid flexure, which pressure is maintained at the same time upon the dilator in the manner described; another practical point of prime importance is to employ an abundant stream of water, projecting it through the conduit of the instrument as warm as can be comfortably borne, whenever its point is arrested from any cause: the water flowing from the distal aperture will distend the bowel, efface its folds, and break down any hardened fæces that may exist, obstructing the ascent of the dilator; while the operator is engaged with the dilator, an assistant may manage the syringe and throw in the water in such quantities as may be needed; it must be borne in mind, however, that no great volume should be used at once, otherwise the bowel will be excited to energetic contraction, and compel the dilator to be withdrawn before it has been properly

[1] P. S. Wales.

lodged. In preliminary trials, the dilator may be permitted to remain two or three minutes, and afterwards, when greater tolerance is established, a longer stay may be allowed. After several introductions of one size of the dilators, perhaps seven or eight, the next largest may be taken, and so on until the stricture has been sufficiently expanded. The application of the instrument may be repeated twice or thrice a week, according to circumstances, such as the irritability of the rectum, temperament of the individual, and intercurrent attacks of diarrhœa or other trouble.

If the stricture becomes impassable, an operation must be undertaken for its relief; this consists in opening the colon, colotomy, at a suitable point, and the formation of an artificial anus. If the stricture is in the ascending or transverse colon, the operation should be on the right side, and if at the sigmoid flexure, on the left side.

3. **Colotomy**, section of the colon, for the relief of obstruction of the intestine by stricture or morbid growths, should be performed in the lumbar region,[1] for the purpose of opening the colon on the posterior surface, where it is uncovered by the peritoneum.

The important anatomical features of this region are as follows: It is a quadrilateral space bounded above by the last rib, below by the iliac crest, behind by the longissimus dorsi and sacro lumbalis muscles, and anteriorly by a vertical line drawn from the centre of the crest of the ilium to the last rib: in this space the colon lies in front of the kidney and separated from it by adipose tissue; the centre of this space corresponds with the fascia transversalis, and is separated from the quadratus lumborum muscle by some adipose tissue: anteriorly and externally the colon is in contact with the small intestines, and its distance from the spine varies according as it is contracted or distended; if contracted, the space between the peritoneal folds behind is slight, but when distended, the portion uncovered by peritoneum is increased.[2] The conclusion as to the precise location of the colon, based on more than fifty dissections, is, that it is always normally situated half an inch posterior to the centre of the crest of the ilium, or a point midway between the anterior and posterior spinous processes.[3] Before operating it is well to mark out the two processes, then find the centre point between them and draw a vertical line full half an inch behind this centre [2] spot. By attention to these rules, the operation will not be found very difficult, and when the gut is much distended and the patient thin, nothing can well be easier; this is not the case when the bowel is collapsed and the patient muscular or fat. The numerous failures to find the colon are due to the fact that it has been looked for too far from the spine.[3]

When the bowel is collapsed there is an advantage in distending it by an injection of warm water or of air.[3] This must be done when the patient is under the influence of an anæsthetic; distention by air is most cleanly and manageable; to retain the injection the rectum must be plugged with wet lint, retained by the finger of an assistant.[2]

Proceed as follows,[4] the operation being on the left side: Place the patient on the right side, with a pillow under the loin, that the left loin may be thrown into greater prominence; make an incision four inches long, somewhat obliquely between the crest of the ilium

[1] M. Callisen; M. Amussat. [2] E. Mason. [3] W. Allingham. [4] C. Heath.

and the last rib, half of the incision being on each side of the vertical line marked out (Fig. 372); the direction of the incision has been vertical,[1] transverse,[2] and oblique;[3] but the slightly oblique incision, running parallel to the last rib, should be preferred; divide the skin, subcutaneous fat, the external oblique and latissimus dorsi muscles, thus exposing the internal oblique; divide it the whole length of the wound until the fascia lumborum comes into view, which carefully divide on a director; the loose fat is now exposed about the kidney and colon in the anterior part of the wound, and the edge of the quadratus lumborum behind; keep the edges of the wound open with spatulæ, and displace the fat with the finger and seek for the bowel; in cases of obstruction with distention, there is no trouble in doing this, the bowel presenting at the wound covered only by fascia transversalis; this fascia varies in thickness in different cases, and has sometimes been mistaken for peritoneum; if the bowel be empty, tear through the fascia transversalis carefully with the finger-nail just in front of the quadratus lumborum, introduce the forefinger, and hook the intestine; if this does not succeed, turn the patient over upon his back and the bowel will, in all probability, fall on the finger; bring the bowel into the wound, roll it round and expose the posterior surface, which is generally uncovered by peritoneum, and, when the bowel is distended, this surface is much larger; with a large curved needle pass a stout silk thread through the skin to one side of the mark, across the bowel, and again through the skin at a corresponding point on the other side of the mark, repeating the proceeding at the other end of the incision; thus the colon is held to the margins of the wound before being opened; make a transverse incision into the bowel between the threads, and, the finger being introduced, the two loops can be drawn out, and, on dividing them, four threads only are required to be tied to fix the bowel to the wound; close the rest of the incision on each side of the bowel by ordinary sutures (Fig. 373).

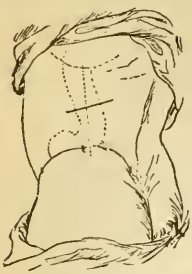


Fig. 372.

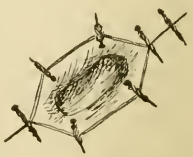


Fig. 373.

The colon may be recognized[4] by (1) its distention and greenish hue; (2) its peculiar bands; (3) its quiescence during respiration while the small intestines move.

The after-treatment[4] differs in no respect from that of any other wound; it may be covered at first with lint spread with oxide of zinc

[1] M. Callisen. [2] M. Amussat. [3] M. Baudens. [4] E. Mason.

ointment, and with carbolic acid; this is changed when soiled; after the bowels have been moved freely, a pad of oakum may be placed over the opening and a bandage applied; the stitches confining the bowel to the integument may be removed on the fourth or fifth day, or be left to separate; if the case progress favorably, the patient may sit up in bed on the fifth or sixth day; if fæcal matters pass down into the rectum below, an enema will remove them. If the disease for which the operation is performed is recovered from, the artificial anus frequently closes, proving that the effort to close the opening, when no longer required, should be attempted.[1]

4. **Cancer of the colon** is most frequent in the sigmoid flexure. These growths are almost exclusively gland cancers; the proliferation proceeds from the large glands of the large intestines, and grow in the shape of tortuous and branched tubes; the calibre of the gland is often maintained, but it fills with mucus, and the cylinder cells may maintain their form and become very large; at first the muscular coat of the intestine is hypertrophied, but subsequently it is also affected by the ulceration, which begins early.[2] The symptoms are those of chronic obstruction, to which are added the cancerous cachexia and the detection of a tumor. The treatment is colotomy. Though the operation is in no sense curative, it undoubtedly prolongs life and renders it comfortable.[3] To derive its full value, the operation should be performed at an early period, before the stricture becomes impassable. If it is delayed until the vital powers are worn out by long-continued suffering, or until absolute constipation occurs, the shock may be so great that life is forfeited.

CHAPTER XXXVIII.

THE RECTUM.

THE rectum commences opposite the left sacro-iliac articulation, and is directed at first obliquely downwards, and from left to right, to gain the middle line of the sacrum; it then changes its direction and curves forward in front of the lower part of the sacrum and the coccyx, and opposite the prostate gland turns backwards and downwards to reach the anus; it is from six to eight inches in length, and is rather narrower than the sigmoid flexure at its upper end, but becomes dilated into a large ampulla or reservoir immediately above the anus.[4]

1. **Exploration of the rectum** may be with the finger, hand,

[1] E. Mason. [2] T. Billroth. [3] T. B. Curling; Sir J. Paget. [4] Quain's Anat.

or speculum. In exploring with the finger,[1] place the patient on the side, with the knees well drawn up; lubricate the finger well with oil, and pass it gently through the anus, avoiding any rude movements; by pushing with force and burying the knuckle in the perineum, a distance of four or five inches from the anus may be reached; if now the patient bear down, the exploration may extend six inches. Exploration with the hand[2] must be performed with great caution, to avoid rupturing the mucous membrane or other tissues; the patient being fully anæsthetized, place him on the back with the knees drawn upwards; the hand and arm being well oiled, give a conical form to the tips of the fingers, and apply the palm of the thumb to that of the fingers, its tip placed between the index and little fingers; gently insinuate the tips into the anus with a semi-rotatory motion, and continue the process until the hand is lodged in the rectum; the dilatation of the sphincter should be very gradual, and should occupy at least five minutes; when once through the sphincter, the windings of the gut should be followed by a semi-rotatory movement of the hand, and by alternate semiflexing and extending the fingers; in many cases the hand can be passed into the sigmoid flexure, and possibly, in rare instances, into the descending colon; should the hand meet with a feeling of constriction about the junction of the first and second portions of the rectum, no force on any account should be used to overcome it, as this can only be accomplished by rupturing the peritoneum, which is here reflected from the intestine. Specula have a limited value in their application, and when employed, anæsthesia is a most valuable aid.[1] For thorough exploration place the patient, when under the full influence of an anæsthetic, on a table of proper height, or on a uterine chair, and in a good light, the body in the prone position, with outspread arms and the hips properly elevated; introduce a speculum vaginæ, or a similar form, (Fig. 374), and elevate the posterior wall; the whole internal surface of the rectum as high up as its termination in the sigmoid flexure, may be exposed to view.[1]

Fig. 374.

A great variety of specula have been introduced into practice, but those forms

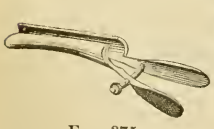


Fig. 375.

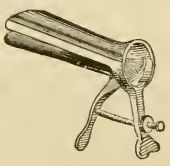


Fig. 376.

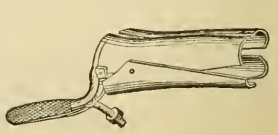


Fig. 377.

[1] W. H. Van Buren. [2] G. Simon; W. J. Walsham.

have the greatest value which contract and expand, as they admit of easy introduction, and give the largest exposure of the internal cavity; the vaginal specula of this kind answer a good purpose; such are the bivalve (Fig. 375); the trivalve (Fig. 376); the quadrivalve (Fig. 377); the irregular form, which may close (Fig. 378), or open (Fig. 379);[1] or, the still more compact and expansible instrument (Figs. 380, 381);[2] or, finally, a still more open instrument (Fig. 382).

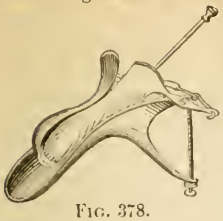


Fig. 378.

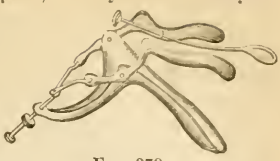


Fig. 379.

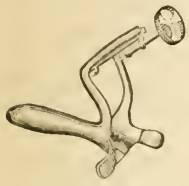


Fig. 380.

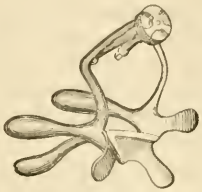


Fig. 381.

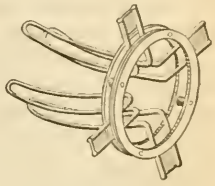


Fig. 382.

2. **Medication by the rectum** is chiefly required for the purpose of procuring an evacuation of the bowels, or for administering remedies which it is not advisable to give by the stomach. The common syringe, with barrel and piston (Fig. 383), is now employed only to give small quantities of fluid, as in administering an anodyne injection. For injections in bulk, and for general use, the rubber bulbous syringe[3] is preferable (Fig. 384). Or, the apparatus[4] may consist of an elastic air-bulb *a*, a stand pipe *c*, which rests in the bowl, the pipe *d*, and the nozzle *e* (Fig. 385).

Fig. 383.

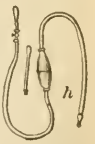


Fig. 384.

The enema, though of daily use, is rarely administered with requisite skill, being too often intrusted to those ignorant of its nature and purposes; it must be accurately adapted in quantity and quality to the capacity and tolerance of the bowel and be so administered as not to pain, irritate, or injure the parts.[5] An enema consists of the menstruum, as water, boiled starch, mint tea, and the ingredients, which are laxative, stimulating, anodyne, or nutritious; the quantity used must depend upon the effect desired, these facts being borne in mind, namely, (1) the larger the quantity the more promptly the bowels act, and

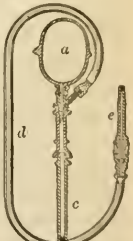


Fig. 385.

[1] J. C. Nott. [2] N. Bozeman. [3] Davidson. [4] Mattson. [5] S. D Gross.

vice versa; (2) three times more in quantity are required by the rectum than the stomach; (3) absorption by the rectum requires double the time of the stomach. The ordinary injection is given as follows: inject the fluid through the tube until all air is expelled; place the patient on the side, with the thighs flexed; separate the nates and gently insert the tube, passing it first slightly forward towards the umbilicus, then backward towards the cavity of the sacrum; when the tube has entered two to three inches, force the fluid slowly into the bowel until the requisite quantity is given; withdraw the tube very slowly, and if there is any tendency to escape, press a cloth firmly against the parts.

3. **Alimentation by the rectum**[1] is required in diseases of the œsophagus preventing swallowing, and in diseases of the stomach which prevent the retention or ingestion of food; life may in this manner be maintained for long periods. The nutritive injection should be composed of materials which need no digestion, as milk, eggs, mutton and chicken broths.

Pancreatic meat emulsion[2] should be made as follows: to five to ten ounces of finely chopped meat add one third of that weight of the fresh pancreas of the ox; remove the fat and mix with about five ounces of water, and reduce the whole to the consistence of a thick soup. Or, the following preparation may be used: crush or grind a pound of beef muscle fine, add one pint of cold water, allow it to macerate three fourths of an hour, now raise it to the boiling point and let it boil two minutes and stand.[3]

The quantity used should be three or four ounces every four hours, and it should be tepid. The bowels should first be moved by a laxative or enema; the injection should be very gently thrown into the rectum; at first it may not be retained, but by repetition and pressure upon the anus, tolerance is established; or opium may be added to the enema; if at any time the rectum becomes irritable the injection may be carried to the colon;[4] as a substitute for drink, water may be thrown into the rectum; the rectum need not be washed out before each enema.

4. **Imperforate rectum** is caused by a membranous partition which may be just within the anus or an inch or more above; it varies in thickness, but is usually thin; the symptoms are retention of the meconium and vomiting. Examination with the finger or probe, or a small elastic catheter or bougie determines its nature; if the membrane is thick, it may not be possible to decide whether the intestine is continuous above till an incision is made, but if it is thin it will bulge down upon the finger, especially when the child cries.[5] Delay the operation a day or two, until the meconium dilates the lower part of the intestine; if the septum is thin, break it down

[1] A. Flint. [2] W. Leube. [3] E. R. Peaslee. [4] F. Barker. [5] T. J. Ashton.

with the end of the little finger; if thick, puncture with a sharp-pointed bistoury, the blade being wrapped with thread, and cautiously carried into the passage on a grooved director, or along the finger; enlarge the puncture by a crucial incision; dilate with the end of the little finger, or a dressing forceps; pass the finger, or a bougie of suitable size, daily, for several months.

5. **Absence of the rectum** may be partial, which is most common,[1] or complete, the anus being normal. When only partially absent, the other portion usually terminates in a cul-de-sac, at a greater or less distance from the surface of the body, or it may be prolonged as a narrow tube or imperforate cord, and blended with adjacent parts; if wholly absent, the canal may open in some abnormal situation.[2] The diagnosis is made by examination with the finger or a bougie. If the occlusion is not thick, it is only necessary to incise the intervening tissues, and dilate. If the part is very thick and hard, dilate the anus, if necessary add lateral incisions; separate the mucous membrane, and draw down the rectum; cut off that portion including the septum, and attach the margin by suture to the skin.[3] If the rectum is wholly absent, and the bowel cannot be reached by dissection, a last resort is to make an artificial anus.

6. **Laceration** may involve the mucous membrane only; or all of the coats of the rectum; incomplete laceration is generally the result of the expulsion of hardened fæces, and is vertical when it results from undue distention of the anus during the violent efforts of the expulsive muscles, and transverse when a fold of mucous membrane falls under a mass of indurated fæces at the moment of its forcible extrusion; complete laceration occurs in parturition, and from external violence, as blows, the passage of an injection-pipe or catheter, or foreign bodies lodged in the rectum, or penetrating through the anus. The treatment of incomplete laceration consists in protecting the wound from irritation by emollient enemata, cleansing the surface, and the application of nitrate of silver, if healing does not progress favorably; in complete laceration, it may be possible to close the wound by suture, but if not, it must be treated as a fistula.

7. **Abscess near the rectum**, if acute, appears as a throbbing swelling, hot and painful, with fever; if subacute, there may be little or no pain; if it is difficult to detect the presence of pus, owing to the elasticity of the cellular tissue and its depth from the surface; introduce one or two fingers into the rectum and make counter pressure, by which means fluctuation is easily discovered; when pus is detected, open the abscess by puncture; the after treatment consists of poultices, care being taken to prevent the external wound

[1] G. Bushe. [2] T. J. Ashton. [3] M. Amussat.

healing before the cavity of the abscess, by the insertion of tents occasionally.[1]

As a rule, however, to which exception is rare, these abscesses do not heal, but become fistulous (Figs. 391, 392, 393), owing to the constant motion to which the healing part is subjected by the proximity of the restless sphincter muscle, and the muscular pouch of the rectum, which is continually varying in volume; to guard against censure, warn the patient of this contingency before opening the abscess.[2]

8. **Stricture of the rectum** is the result of any cause which induces a thickening and contraction of the coats of the bowel in that region, as injuries, specific or malignant disease. (1.) Simple stricture follows the organization of the products of inflammation in the submucous cellular tissue and muscular coat; in severe and long continued cases, the fibrous deposit is more extensive and dense, and in addition to a very narrow contraction there is a large amount of thickening of the coats of the bowel, but there may be a considerable contraction with slight consolidation of the surrounding tissues; in rare instances, the stricture is due only to fibrous bands running across the bowel, or it involves only a portion of its circumference; the extent of bowel affected varies from one or two lines to half an inch, an inch and a half, or even three or four inches; the bowel above is generally more or less dilated, with increase of its muscular coat, while the mucous membrane is vascular, thickened, or even ulcerated.[3] Its usual location is within two or three inches of the anus, and it can readily be detected by the finger; rarely, it is found higher up, even in the sigmoid flexure.[1] The symptoms are referrible directly, or indirectly, to the mechanical obstruction to the function of the bowel which it occasions, the more prominent being, at first, costiveness, or difficulty in evacuating the lower bowel, the fæces escaping in narrow, tape-like coils, when the stricture is near the anus; and later, costiveness alternating with diarrhœa, due to the inflamed and altered mucous membrane above the stricture, which now yields mucus mingled with pus and blood.[2] The existence of stricture is definitely made out, by the finger within the rectum, when within its reach; the canal feels narrow, indurated, and unyielding, though in some instances the finger may pass through the obstructed portion; if the stricture is higher up, it may be brought within reach of the finger by the bearing down effort of the patient;[4] or, the patient standing erect and forcing down, may render the examination with the finger conclusive.[5] Stricture at higher points is diagnosed with difficulty, as there is no positive evidence of its existence but that obtained by the touch;[6] reliance must be placed upon

[1] T. J. Ashton. [2] W. H. Van Buren. [3] H. Smith. [4] G. Bushe.
[5] J. P. Batchelder. [6] R. Quain.

symptoms, explorations with the olive or rubber bougies, aided by inspection by means of the speculum,[1] when the patient is in the prone position, on the knees and elbows.

The treatment is dilatation, which is best effected with bougies; they meet two indications, namely, mechanical stretching of the contracted tissues, and stimulation of absorption of the recently organized material which constitutes the substance of the stricture; the bougies should be smooth, conical at the extremity, and of half a dozen different sizes, varying from that of the largest urethral bougie to the diameter of an inch and a half.[2] The gum elastic and metallic instruments in common use do not compare in efficiency and pliability with the soft rubber[3] dilators (Fig. 371), and should never be used when the stricture is beyond the reach of the finger. Select a dilator of sufficient length to extend beyond the stricture, and of a size to pass through it without force; previous to its introduction, empty the bladder, and wash out the rectum with warm water; warm and oil the bougie, to render it pliable; place the patient on the left side, or require him to lean over a chair, or kneel on his bed; the buttocks being separated, introduce the bougie upwards and a little backwards with the convexity towards the sacrum, avoiding all force; when suddenly checked, withdraw the instrument somewhat, and give it a different direction; if the stricture is more than five or six inches from the anus, turn the point of the instrument a little forwards and to the left side, to avoid the sacrum and enter the sigmoid flexure.[4] The bougie should not be left in the rectum, in contact with the altered parts, more than fifteen or twenty minutes, and it is sufficient in most cases to introduce it every second day. To aid the process of dilatation, the knife may be employed in making very limited incisions, or nicking the most resisting points of the stricture, especially when it is diaphragmatic, linear, or bridle-like,[2] or of traumatic origin with a dense cicatrix, and situated at the verge or within a short distance of the anus. Operate thus; carry a straight, narrow-bladed bistoury on the left fore-finger within the stricture and notch it at several points; introduce a bougie for a minute or two, and on its withdrawal pass a suppository into the rectum.[5]

Linear rectotomy[6] is recommended for the cure of stricture which is greatly indurated, with softening of the mucous membrane by growths, ulcerations, and fistulous passages; it is adapted only to strictures within three and a half or four inches of the anus, or where the peritoneum is not liable to be implicated; the patient lying on the back, and being under the anæsthetic, with the index finger of the left hand as a guide, pass a straight bistoury to the upper limit of the stricture in the posterior median line; now incise the bowel slowly until the entire thickness is divided throughout the whole extent, including the anus.

[1] J. M. Sims. [2] W. H. Van Buren. [3] P. S. Wales. [4] G. Bushe. [5] H. Smith. [6] L. Verneuil.

The after-treatment requires the occasional passage of a rectal bougie, during the period of repair, to prevent recontraction.

Other methods, having limited approval, are, forcible dilatation to the extent of laceration of the stricture, great caution being observed in view of the possibility of fæcal extravasation and pelvic cellulitis and abscess.[1] Such dilatation may be effected with dilators, of which there is a variety, but all are constructed on the same principle. Or the dilatation may be effected with a membrane which is applied to the stem of the instrument, through which there is a canal into which water can be forced;[2] the soft rubber dilators[3] have a hood which may be dilated in a similar manner and are preferable.

It must be constantly borne in mind, in the after-treatment, that simple stricture is never so cured as to require no further treatment after complete dilatation is effected; there is a constant tendency to contraction which must be resisted for years by the occasional introduction of the bougie by the patient.[4] (2.) Venereal or syphilitic stricture results from the healing of chancroidal ulcers of the rectum, the walls having become inoculated by the secretions from external sores, or impure connection, or from inflammation extending from chancroids about the anus to the areolar tissue of the rectum, followed by organization of its products, or ulceration of the mucous membrane.

It occurs almost exclusively in females, its most frequent site being between one and two inches from the anus; its symptoms do not materially differ from simple stricture, but the presence of chancroidal cicatrices on the genitals confirms the diagnosis; the treatment is by dilatation, antisyphilitic remedies being valueless.[5] In old strictures which resist all treatment and become sources of permanent ill health, lumbar colotomy may with propriety be performed.[6]

9. **Prolapse of the rectum** is the protrusion from the anus of the coats of the rectum; the length varies from one to six inches, or even more, and the shape and appearance depends upon its size, and the condition of the external sphincter; it may form a rounded swelling which overlaps the anus, or have the form of an elongated pyriform tumor, the free extremity being tilted forwards or to one side; if the sphincter is relaxed, the surface will have the normal color of mucous membrane, but if contracted, the color may be violet or livid; the exposed mucous membrane is often thickened and granular, and sometimes ulcerated, and the connective tissue infiltrated.[7] It is most frequent in children, owing to less curvature of the sacrum, the cartilaginous state of the coccyx, the straighter direction of the rectum.[8] The causes are (1) constitutional, as general debility, and (2) local, as diarrhœa, or constipation, polypi, stone in the bladder, stricture of the urethra.[9]

The treatment must first be directed to the replacement of the

[1] W. H. Van Buren. [2] J. Arnott; W. R. Whitehead. [3] P. S. Wales.
[4] G. Bushe; T. J. Ashton; H. Smith. [5] L. Gosselin; E. Mason.
[6] W. Allingham. [7] T. B. Curling. [8] T. J. Ashton. [9] H. Smith.

bowel. Place the patient on his side, or on his knees and elbows; the buttocks being separated, grasp the tumor in a piece of oiled linen, make firm compression, and, having reduced its volume, push it within the sphincter; if there is much congestion, apply cold, or if inflammation is present and prevents reduction, resort to leeches, followed by hot fomentations of the decoction of poppy heads; should contraction of the sphincter interfere, give an anæsthetic, and if relaxation is not sufficient, divide the sphincter by carrying the knife on the finger nail introduced within the bowel; when the bowel is returned, apply a pad of lint and retain with the T-bandage.[1] The next step is the removal of the cause, which, in children, may generally be effected, rendering any but the simplest local measures necessary for a permanent cure.[2] In the adult, if of long standing, prolapse of the rectum will rarely admit of being remedied, except by an operation,[1] which shall result in such a degree of the adhesive process as shall prevent the descent of the bowel.[3] The object to be obtained is to reduce the redundancy or relaxation of the mucous membrane, promote adhesion between the several tissues, and brace up the anus and sphincter.[4] In the treatment of simple prolapsus, where there are one or more large folds of mucous membrane, and the tissue is extremely vascular, presenting the appearance of smooth velvet, or is superficially ulcerated and readily bleeds, apply the strong nitric acid[5] carefully to the whole or greater part of the diseased membrane with the same precautions as to hæmorrhoids; if the surface is extensive, make the application to a part only, and repeat.[4] In more severe forms apply a clamp to the mucous membrane and destroy the included portion with the actual or galvanic cautery.[6] Rest should be maintained, opium given to relieve pain, and hæmorrhage should be suppressed by cold.

Other methods are as follows: With toothed forceps, pinch up one, two, or more folds of mucous membrane, on opposite sides of the bowel, and include them in a firm ligature;[7] when the prolapsus is very large, and a considerable portion of the mucous membrane has become converted into tissue, approaching integument, remove loose pendulous flaps of skin which exist around the margin of the anus,[8] and portions of the mucous membrane,[9] as follows: seize the fold of skin on each side of the anus with forceps, and with curved scissors remove both the skin and mucous membrane; in very severe cases four or six applications of the scissors may be necessary.[4]

10. **Polypus of the rectum** is composed of a somewhat loose, fibrous, or fibro-cellular tissue, covered by natural mucous membrane. It occurs more frequently in children, is generally single, and pedienlated, and located just above the sphincter; it may be soft and liable to bleed, or firm and resisting; the symptoms at first

[1] T. J. Ashton. [2] T. Holmes. [3] R. Quain. [4] H. Smith. [5] B. C. Brodie. [6] T. Bryant. [7] T. Copeland. [8] W. Hey. [9] Dupuytren.

are slight, but later there is passage of blood, tenesmus, the escape of the tumor which may be mistaken for prolapsed bowel or hemorrhoids; examination of the escaped tumor, its reduction, followed by exploration of the rectum with the finger, determine its nature; if beyond the reach of the finger, the presence of the polypus may be suspected if the fæcal matter is grooved. The treatment is removal.[1] Sometimes the pedicle is so frail that the tumor is detached in the examination.[2] Bring down the tumor by an enema; seize it with forceps and apply a ligature to the pedicle; if the tumor slip under the finger in the effort to bring it down, pass polypus forceps over the finger, seize the tumor, and twist it off its pedicle; arrest hæmorrhage by cold or astringent injections.[1]

11. **Hæmorrhoids**, piles, result essentially from a diseased condition of the venous radicals of the rectum, and have been described in that connection (page 227).

12. **Foreign bodies** found in the rectum are of two kinds: (1) concretions, biliary, intestinal, and fæcal; (2) substances swallowed or introduced through the anus, as pins, nails, fruit-stones, coins, small bones, or pieces of wood, cork, meat, bone, horn, ivory, and metal, pots, cups, bottles, ferrules, rings.[3] The symptoms of the former are gradual in their accession, preceded by signs of derangement of the stomach, liver, and bowels, and weight, distention, and pain in the rectum, followed by obstinate constipation, great straining, with more or less prolapsus of the mucous membrane and congestion; exploration with the finger reveals the nature of fæcal accumulations, and the presence of foreign bodies; information as to substances swallowed can seldom be obtained, as the patient is generally unconscious of the fact. When the foreign substance has been introduced into the rectum the symptoms are more rapid in their development, and the patient may explain the nature and method of introduction of the foreign body.[4] In the removal of such substances great care must be exercised, that the coats of the bowel be not injured. The following instruments may be required: blunt hooks, lever, gimlet, cutting forceps, strong long scissors with probe points, a six-inch narrow saw, polypus and lithotomy forceps, speculum, strong waxed ligatures, metallic tubes, a probe-pointed bistoury; to all of which a crooked finger and small hand are important adjuncts.[3] Fæcal accumulations are best broken up with a lithotomy scoop, or the handle of a firm spoon. As a rule, extract the larger portion and remove the remainder with injections.[5] The removal of concretions and solid substances must be effected with the finger, or with forceps. Should the substance be a bottle, or jar of glass, or earthenware,

[1] H. Guersant. [2] T. Holmes. [3] G. Bushe. [4] T. J. Ashton. [5] T. B. Curling.

insert slips of thin ivory, wood, or gutta-percha, between it and the bowel, and thus form a tube around it, which will facilitate its extraction and protect the intestine from injury in case the body should be broken; the anus being very dilatable, it will rarely be necessary to divide the sphincters, unless the foreign body is sharp and angular and has penetrated the intestines.[1]

13. **Cancer of the rectum**[2] is almost exclusively of the form of gland cancer, as it commences in the glands which grow in the shape of tortuous and branched tubes; the interstitial connective tissue is strewn with small, round cells, sometimes softened and often very vascular; the muscular coat may be at first hypertrophied, but subsequently it is also affected by the ulceration. The first symptoms are usually constipation, discharge of mucus and slight hæmorrhage, which leads to the treatment for hæmorrhoids before the diagnosis is made out; but the induration and nodular infiltration, leaf-like proliferations, commencing close above the sphincter ani, soon extend to the whole circumference of the mucous membrane, so that a thick and prominent ring, forming a stricture of variable length, may be felt; at later periods an ulcer is found with elevated edges and indurated base, and the parts around are infiltrated with medullary substance, while at some points there is cicatricial tissue; the inguinal and retroperitoneal glands are affected rarely and late in the disease; death generally results from the stricture, from marasmus due to hæmorrhages, and putrefaction of the cancerous tissue. This new formation can only be removed by extirpation.

14. **Extirpation of the rectum** may involve only a small section of the tube or the entire bowel, or both the rectum and anus, according to the extent of the disease; complete extirpation has given the most satisfactory results.[3] Operate as follows: the bowels having been thoroughly cleared by injection, place the patient, anæsthetized, on the back and in the position for lithotomy, the limbs being supported; empty the bladder, and in the male introduce a sound as a guide; if the anus is involved, commence an incision at the centre of the perineum and carry it along the raphé to the anus, encircle the anus, and continue along the median line to the coccyx; dissect along this incision until the rectum is exposed; now with the fingers or handle of the scalpel continue to expose the bowel until a point is gained above the diseased mass; draw the bowel down through the wound, pass ligatures through the healthy portion and carefully divide it, tying all bleeding vessels; the stump of intestine is now to be attached to the integument along the margin of the wound by sutures passed from within outwardly. If the anus is not diseased, it may remain, the bowel being reached by an incision from the anus

[1] T. J. Ashton. [2] T. Billroth. [3] R. Volkmann.

to the coccyx, but early and total extirpation, including the sphincter, is to be regarded as the safer method. If the peritoneal cavity is opened during the operation, use salicylic acid, instead of carbolic solution, applied to the peritoneal wound with a sponge; but as soon as the tumor is removed enlarge the external wound and close the peritoneal wound with sutures. Drainage tubes must be inserted so as effectually to remove all secretions and allow frequent cleansing by the injection of carbolic solutions; tubes may be placed between the sutures, and additional external openings may be required on either side, through which catheters may be carried to the upper part of the wound, for the purpose of cleansing with disinfectant solutions. The after treatment must be antiseptic as to the wound, and in general such as to secure quiet of the bowels by opium; proper nutrition by easily-digested food, as milk, beef tea, raw eggs; and perfect cleanliness of the wound externally and internally; the sutures must be removed when they become loose. The first inconvenience is from incontinence of fæces, but this condition soon becomes easily tolerated, and with soft pads and bandage the patient is protected.

It is important to provide for the escape of gases after the operation. For this purpose, an egg-shaped air pessary of caoutchouc may be employed;[1] it consists of a thin, soft, India-rubber bag with a flexible tube eight inches long, ending in a stop-cock, and traversed in its long diameter by an ordinary gum catheter of full size; the bag is air-tight, and distensible at will through the tube stop-cock; when used it is introduced into the rectum after the operation and gently distended so as to reduce the area of the surrounding extra-rectal cavity to a minimum; the gases now escape freely, and the distention of the bowel greatly diminishes the internal area of the wound.

The rectum, prostate, and base of the bladder have been successfully removed for cancer,[2] as follows: A semilunar incision was made around the anus on both sides; the healthy muscular fibres of the sphincter were pushed aside, and the finger passed up to the extent of four inches, where healthy tissue, was found surrounding the rectum, except in the anterior fourth, where the bladder and prostate were involved in the cancer; the adherent portion of the prostate was cut through, with the urethra contained in it; arteries were tied and the sound portion of the rectum drawn down and freed from the cancerous tissues; the healthy intestine was then attached to the skin by sutures; recovery was satisfactory.

CHAPTER XXXIX.

THE ANUS.

The anus,[3] the lower opening of the alimentary canal, is a dilatable orifice, surrounded internally by the mucous membrane, and externally by the skin.

[1] W. H. Van Buren. [2] Von Nussbaum. [3] Quain's Anat.

These membranes here become continuous and pass into each other; the lower end of the rectum and the margin of the anus are embraced by the following muscles: the internal sphincter, the levators ani, the coccygei, and the external sphincter.

1. **Exploration of the anus** is made as follows:[1] place the patient in a good light, with the body flexed and resting on the elbows and the knees; by separating the buttocks, and gently forcing asunder the margins of the anal orifice with the thumbs, a good view of the radiating plaits and of the festooned line of junction of skin and mucous membrane may be had, and possibly of the lower margin of an irritable ulcer; by urging the patient gently and repeatedly to bear down, a hæmorrhoidal tumor may be protruded.

2. **Contraction of the anus** may be due to a congenital narrowing of the lower part of the rectum and the anus, or of the anal orifice alone, or the integument may extend partially over the anus; the situation and form of the anus are generally normal, but the orifice is puckered or plicated; the narrowing may be slight, or only admit the passage of a probe. The symptoms are absence of meconium, and progressive, painful tension of the abdomen, and vomiting. Contraction may also result from operations, injuries, syphilitic sores. The treatment is dilatation: Select a graduated bougie, the tip of which readily passes the contraction; inject a little oil to lubricate the parts; or, if there are fæces in the rectum, move the bowels first with an enema; place the patient on the back with the thighs well flexed; warm and oil the bougie, and pass it gently but firmly into the constriction; repeat the operation, daily, until the part is enlarged to at least its normal calibre; the finger may be substituted for the bougie when the stricture is sufficiently dilated.

If the narrowing is extreme, and very rigid and unyielding, incise the lateral surfaces on a director, and in the direction of the tuber ischii, to such a depth as to allow the passage of the fæces; if the first incisions are not sufficiently deep repeat them; but it is necessary to divide only slightly or partially the sphincter. If the narrowing is due to extension of the integument, incise it in several places on the director, and dilate daily with a bougie or with the little finger.

3. **Imperforate anus** is generally caused by a lamina of fibrocellular tissue, usually thin and transparent, permitting the meconium to be seen through it, and forming a small, roundish prominence, which is most distinct when the child cries or strains; the bulging membrane gives to the finger a doughy feel and sense of obscure fluctuation; on pressure, it recedes, but reappears on removal of the finger; the membrane may be very thick and dense, especially at the circumference, when the protrusion will be less prominent.[2] The nature of the affection is apparent on inspection. If the mem-

[1] W. H. Van Buren. [2] T. J. Ashton.

brane is thin, incise it at once; if it is thick, and there is a doubt as to the continuation of the rectum, delay a day or two for the rectum to become distended; then, while the child is held on its back, on the knees of an assistant, the thighs strongly flexed, make a crucial incision through the membrane, the point of intersection of the incisions being the centre of the anus; remove the intervening flaps with scissors, and dilate the opening daily with the finger or a bougie.[1]

4. **Absence of the anus** is characterized by the obliteration of every trace of the orifice, the perineal raphe extending from the scrotum to the point of the coccyx without interruption, and the space of the anus being occupied with cellulo-fibrous tissue; there are no external signs by which the location, or even existence of the rectum, can certainly be ascertained; if it is present, and near the perineum, fluctuation may sometimes be detected by the finger in the perineum, or by pushing firmly up in the direction of the rectum, while with the left hand firm pressure is made upon the anterior walls of the abdomen inward and downward towards the finger in the perineum.[2] If by these manipulations the presence of the rectum is detected, an operation will afford the desired relief. The patient being held by the assistant, as before described, and, if necessary, the sound introduced, make an incision in the median line from a point near the scrotum to the extremity of the coccyx (Fig. 386), through the skin and superficial fascia; repeat the incisions, but of gradually diminishing length, carefully feeling before each stroke, to ascertain by fluctuation the presence of the blind sac of the rectum, and also the position of the bladder or vagina; if the rectum is not found in the middle line, search posteriorly, as the extremity is sometimes displaced from the centre; the bowel will be detected as a fluctuating tumor, more or less elastic, and of a dark brown color; when recognized, seize it with strong-toothed forceps, or pass a needle armed with a double ligature through it and gently draw it downwards; adhesions may be broken up with the fingers, or the knife, or scissors; when brought down to a level with the integument, open the cul-de-sac longitudinally, empty its contents, thoroughly cleanse the part, and unite the margin, by six points of suture (Fig. 387), to the integument of the corresponding edges of the perineal

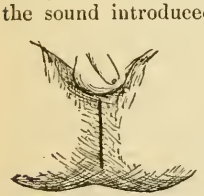


Fig. 386.

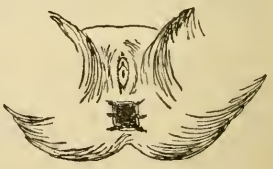


Fig. 387.

[1] T. J. Ashton. [2] W. Bodenhamer.

wound in the exact situation of the anus; the mucous membrane should overlap the external skin, to prevent the escape of fæcal matters into the cellular tissue; close the wound anteriorly and posteriorly by suture; bind the child's legs together with a bandage, and apply cooling lotions to the wound; tendency to undue contraction must be counteracted by dilatation.

If it is found impossible to bring the bowel down, it must be opened by a longitudinal incision at its extremity, and allowed to remain in its position, the external opening being kept patulous by means of curved silver cannulæ, in order to form that portion of the rectum absent.[1] Or, resection of the os coccygis[2] may be performed, and the rectum exposed and brought down and attached to the skin.

5. **Abnormal anus** is characterized by the existence of fistulous openings, through which fæcal matters are discharged at unusual points, the normal anus being imperforate; the malformation is recognized by the absence of the anus and the escape of fæcal matters from unusual outlets, as the vagina or urinary bladder. The treatment consists in establishing a more favorable outlet, when the abnormal anus is a source of ill health. There are several varieties which may be the subject of an operation.

6. **The vaginal fistula** may exist either with the rectum perfectly formed, and continuous as a separate canal nearly to the anus, where it is occluded by tissues more or less thick, and having a fistulous communication with the vagina; or the rectum may terminate in a cul-de-sac opposite, or even somewhat above, the vaginal opening; the opening into the vagina varies in size and situation, being generally but a short distance up the canal, but sometimes even near the os uteri; if the opening is of small size, an operation within the first month or two is desirable; the operation is designed (1) to secure and maintain an opening into the bowel at the natural site of the anus; and (2) to close the unnatural opening into the vagina. Where the rectum continues past the vaginal opening down to, or nearly to, the site of the natural anus, introduce a curved probe into the vaginal opening and make it protrude the skin of the perineum at the proper place (Fig. 388); cut down upon the probe to the intestine; now detach and draw down the mucous membrane of the rectum, if possible, and attach by sutures to the edges of the incision, and thus secure a new anus (Fig. 387). But if the rectum, instead of being continued down to the perineum, ends in a cul-de-sac more or

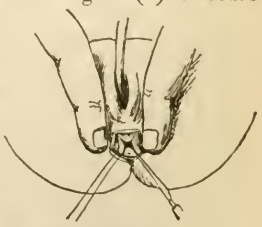


Fig. 388.

[1] M. Amussat; W. Bodenhamer. [2] L. Verneuil.

less high up, near the vaginal opening, dissect upward until the rectum is certainly opened and then if the mucous membrane cannot be brought down and attached to the skin, maintain the permanency of the new opening by the daily introduction of the finger; a roll of oiled linen may be introduced, but should be continued only during the first twenty-four hours; the new outlet being established, the vaginal fistula tends to close, should it remain open it must be subsequently closed by the methods employed for fistulæ of different origin.[1]

Or,[2] introduce into the fistula a director, and with a bistoury lay open the vagina and integuments as far back as the part where the anus should be; remove a small portion of the integuments, if necessary, and dissect down to the termination of the gut, and open it freely; the anterior boundary of the incision is the fistulous opening in the vagina, and posteriorly it would terminate where the natural outlet ought to be found; promote granulations and the cicatrizing of the original opening, and so much of the anterior portion of incision as renders the vagina incomplete; in the mean time keep the remainder open until this shall have been effected; the integuments around the incision retract and thereby obviate the necessity of removing them; the original aperture closes up with that part of the incision connected with it; the vagina becomes complete, and a route direct from the rectum is established, having no communication whatever with the vagina.

7. **The vesical fæcal fistulæ** are manifested by the thickness of the urine, its greenish appearance, its passing only at the time of urinating, and with gases; this fistula is very difficult of relief.[3] In some cases the gut terminates in the bladder, directly after its passage out of the false pelvis; again the rectum descends low down in the pelvis, even nearly to the skin of the perineum.[4] Make the usual dissection for absent rectum, and, if found, treat it as described; if the gut is not found, open the colon in the left groin, as follows:[5] the patient placed on his back, make an incision (Fig. 352) two to three inches in length in the left iliac region, commencing on a line with the anterior superior spinous process of the left ilium and carry it in a direction parallel with Poupart's ligament; cautiously divide, on a director, the successive layers which constitute the abdominal parietes of this region; open the peritoneum and recognize the sigmoid flexure of the colon by the sacculi and transverse bands; pass a ligature through the intestine to keep it in apposition with the opening in the abdominal wall; make a longitudinal incision and give exit to the fæcal matter; employ injecions to cleanse the bowel above and below the opening; adhesions soon unite the intestines to the peritoneum and the anterior wound, when the lips of the wound in the intestines should be united by sutures to the edges of the exter-

[1] J. H. Pooley. [2] J. R. Barton. [3] W. Bodenhamer. [4] T. Holmes. [5] M. Littre.

nal (Fig. 373) wound; the tendency to contraction must be overcome by occasional use of the dilatators. (Fig. 371).

Other forms of fæcal fistulæ may exist at many other points, as in the urethra, the labia majora, in the groin, and even under the scapula; if not found, the colon should be opened as above; the principles of treatment are the same in all, namely, endeavor to form an artificial anus in the proper place, the perineum, or, failing, perform colotomy at any point, even at the cæcum (Fig. 389).

FIG. 389.

8. **Absence of anus and rectum** is rare, and characterized by the obliteration of these parts, and the presence of a dense fibrous tissue in their normal positions: the pelvis is sometimes abnormally contracted;[1] there is no certain indication of the presence or absence of the rectum;[2] the diagnosis can be made definite only by an exploratory operation, as with a grooved needle, or by an aspirating needle, or by careful dissection. If exploration is determined upon, wait a day or more for the rectum to become distended; then insert the needle cautiously in the direction of the greatest curve of the sacrum. If incision is made, give chloroform, and require the patient to be held as for lithotomy; make an incision an inch in length on the spot where the anus ought to be; continue the dissection in the direction the rectum usually takes, not in a direct course through the axis of the pelvis, but backwards along the coccyx, the finger being used as a director, until its full length is attained, or the bowel is reached;[3] exploration should not be made with a trocar,[2] but with a small grooved needle.

9. **Fissure of the anus** appears as an irritable ulcer, and has its origin in a crack in the mucous membrane, where it is about to assume the character of skin; it is more frequent in women, and in persons of an irritable or sensitive nervous system, and in the earlier portion of middle life, but may occur in infants.[4] The predisposing causes are, constriction of the anal orifice from spasmodic action of the sphincter, owing to intestinal irritation produced by the ingesta or acid secretions, from cicatrization of wounds, specific ulcers, injuries, or hæmorrhoids; the exciting causes are constipation, induration of fæcal matter, and violent action of the expulsive muscles requisite for its evacuation.[5] The symptoms at first are experienced only at stool, when at some point there will be a smarting, stinging,

[1] Rokitansky. [2] T. Holmes. [3] B. Bell. [4] W. H. Van Buren. [5] T. J. Ashton.

or prickling sensation; later, the smarting during defecation will be increased, or become burning, or lancinating, followed by excruciating aching and throbbing, with violent, spasmodic contraction of the sphincter muscle, continuing from half an hour to several hours; the stools, when solid, will be streaked with purulent discharge and slightly with blood, and when more soft, will be figured and of small size; when the disease is fully established, the pain will be induced by sneezing, coughing, micturition, forced respiration, and sitting; defecation is dreaded and postponed; highly-seasoned food and fermented liquors aggravate the symptoms; the pain often extends to other parts, and the urinary organs become deranged.[1] In a small proportion of cases the pain does not begin until after the lapse of some time, ten minutes to two hours after the act of defecation.[2] Severe pain in this disease is due to the pinching and kneading inflicted upon the sensitive sore by the successive and unremitting contractions of the fasciculi of ultimate muscular fibres upon which it is immediately situated.[3] The examination is generally attended with much pain, and it is often advisable to administer an anæsthetic; if the ulcer cannot be exposed on separating the parts, the speculum must be used, or the finger may detect its position and extent.[1] The ulcer is met with at or towards the back part of the gut, and not unfrequently opposite or directly below the point of the coccyx; it may vary from the minutest point to the size of the end of the finger, and may be external, within view, or, as a narrow chap or fissure, immediately within the grasp of the external sphincter; or still higher up, as an ulceration of the mucous membrane, covering the internal muscle an inch or more from the extremity of the bowel; the external ulcer has usually a yellow or ash-colored base, but the internal one is often of a vivid red color, and in some instances the edges are undermined.[2] If the patient refuses an operation, slight and recent fissures may be cured by cleanliness and the application of argent. nit., followed by astringents, as a solution of zinci sulph., two grains to an ounce, the bowels remaining at rest. The operations required in those cases which do not heal is very simple and effectual, and should not be long delayed; they consist of incisions of the base of the ulcer or forcible dilatation, with a view to the temporary paralysis of the inflamed muscle.[4] The bowels having been cleared by castor oil or an injection, give an anæsthetic when there is great sensitiveness; without an anæsthetic, introduce the index finger of the left hand, along which pass a probe-pointed, straight bistoury, flatwise, to the upper extremity of the fissure, turn the edge to the ulcer, and make an incision down to healthy tissue the entire length of the ulcer; with an anæsthetic use the speculum; the incisions generally

[1] T. J. Ashton. [2] R. Quain. [3] W. H. Van Buren. [4] T. B. Curling.

divide only the mucous membrane,[1] or the more superficial muscular fibres of the sphincter.[2] If this incision fail, the sphincter must be well divided,[3] but only laterally, for anteriorly the wound might paralyze the sphincter vaginæ in women,[4] and injure the bulb in men, and posteriorly split and separate the fibres of the external sphincter only and be difficult to heal.[5] The after-treatment consists in maintaining cleanliness of the wound, and the use of simple astringent applications.

The incision may be made from without inwards by passing a sharp-pointed, narrow-bladed knife along the base of the ulcer and cutting inwards upon the finger or speculum.[6]

Forcible dilatation of the sphincter causes atony of the muscular tissue, and thus interrupts for a few days that constant motion which prevents the healing of the fissure; it may be most readily accomplished by introducing both thumbs (Fig. 390) well beyond the external sphincter, back to back, then taking a purchase from the buttocks, with the outspread fingers carry the thumbs forcibly apart until the palmar surfaces are arrested by the ischial tuberosities; this act must be performed thoroughly and with about all the strength the surgeon can exert; some of the muscular fibres are generally torn across and the membrane lining the orifice is somewhat abraded or lacerated, but no harm results.[7] Instruments have been devised for making forcible dilatation but they are not preferable to the hands.

Fig. 390.

10. **Fistula in ano** is a sinus leading into the cavity of an unhealed abscess near the rectum, either from the external part, external fistula (Fig. 391), or from the cavity of the rectum, internal

Fig. 391.

Fig. 392.

Fig. 393.

fistula (Fig. 392), or from both, the sinus being continuous through

[1] R. Quain. [2] T. Bryant. [3] B. Boyer. [4] Sir B. Brodie. [5] T. J. Ashton. [6] J. Syme. [7] W. H. Van Buren.

the abscess to the external part, complete fistula (Fig. 393). The external and internal openings differ according to the duration of the disease, being prominent, hard, and round in phthisical patients, and in others, so small as to escape notice. Generally there is but one internal opening, and that is within five or six lines of the margin of the anus, but not unfrequently there are several external openings.[1] In every case of suspected fistula, a careful examination should be made as follows: the patient lying on a table or bed, with the thighs flexed and the buttocks projecting, search for the opening, if it is not evident, by pressing the side of the anus with the finger; a small quantity of pus will ooze from the fistula, when it is pressed upon; now introduce the forefinger, well oiled, into the rectum, which may detect the orifice of the fistula as a small depression on a teat-like elevation; insert a probe, slightly curved, into the external opening, and carry it gently on, varying the position of the point of the probe according to the resistance it meets, but using no force until it emerges at the internal opening, or is felt beneath the mucous membrane.[1] Fistulæ are rarely cured except by incision; but if the patient refuse, other means may be used, as injections of the sinus with a solution of sulph. zinc. or argent. nit., followed by pressure, or cauterization of the whole tract with argent. nit. The operation of laying open the sinus into the rectum is sanctioned by experience as the most prompt, certain, and safe in its results; it is adapted to all cases except when the patient is subject to progressive organic disease in some vital organ, as tubercular disease of the lungs.[2] Clear the bowels with castor-oil; an anæsthetic having been administered, place the patient on the side or back, with the thighs flexed; introduce the index finger of the right or left hand into the rectum, according to the side on which the fistula exists; explore the sinus again with the probe, to determine its peculiarities; now pass a probe-pointed bistoury along the course of the fistula until it emerges through the internal opening, where it should be received upon the end of the finger (Fig. 394); with a sawing motion of the bistoury divide the intervening tissues, and bring the finger and knife out together; if there is difficulty in passing the bistoury introduce a director to guide the bistoury (Fig. 395), or, before incision bring

Fig. 394.

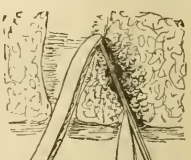


Fig. 395.

[1] T. J. Ashton. [2] W. H. Van Buren.

the end of the director out of the anus on the finger, and then incise the included tissues (Fig. 396); if the internal opening is not readily found, puncture the bowel at a point just above the sphincter;[1] when more than one external opening exists, lay them all open at the time of the operation,[2] but make only a single division of the sphincter;[3] but it may be advisable in persons of feeble nutrition to open the external sinuses and secure their union before completing the operation.[1] If there is hæmorrhage, tie any artery that can be seized; if bleeding is severe, apply graduated compresses, or ice; then insert strips of lint to the incisions and press them firmly to the bottom of each wound; maintain them in position by T-bandage; repeat the dressings only for cleanliness, but always force the lint to the bottom of the wound, without, however, breaking down the granulations.

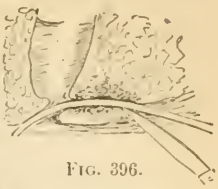


FIG. 396.

When the fistula is of the blind, internal form, find the opening into the rectum by exposing the cavity with the speculum and making external pressure, which forces pus through the opening; now curve a probe so sharply that it can be introduced into this opening and carried down to the bottom of the abscess, beneath the integument; cut upon the probe, and thus render the sinus complete (Fig. 397), and treat it accordingly.[2]

FIG. 397.

Other methods are, the ligature (Fig. 398), galvano-cautery, and écraseur, which are to be preferred only when the incision is dangerous, as in bleeders, or is refused, or in very deep and extensive sinuses. The ligature may be silk, or elastic thread, the latter being now preferred.[4] If silk is used, select twist the thickness of common twine, and insert by means of a very slender silver probe, and secure the ends over a small button having two holes at opposite points, and tighten every second or third day until they cut their way out.[5] If elastic ligature is used, pass an eyed probe through the fistula, and bring it out at the anus; then insert into the eye an elastic thread, the size of a quill, and draw it through the sinus, tighten it and tie two or three knots.[6] The galvano-caustic wire is very easily inserted along the groove of the director; it should be raised to a dull-red heat.[7] The écraseur is passed through the sinus by means of the probe with a thread attached to its eye.

FIG. 398.

[1] W. H. Van Buren. [2] T. J. Ashton. [3] T. Bryant. [4] T. Holmes; T. Bryant. [5] S. D. Gross. [6] V. Romanin. [7] H. G. Piffard.

CHAPTER XL.

THE LIVER; THE SPLEEN.

The liver and spleen are classified as accessory organs of digestion.

I. THE LIVER.

The liver[1] lies under the right hypochondrium and passes across the middle line more or less into the left; the extent to which it can be felt below the edges of the ribs depends upon whether it is enlarged or not, and upon the amount of flatus in the stomach and intestines.

As a rule, in health, its lower border projects about half an inch below the costal cartilages, and can be felt moving up and down with the action of the diaphragm, but it requires an educated hand to feel it; that part which crosses the middle line below the ensiform cartilage is much more accessible to the feel, lying behind the linea alba nearly half way down to the umbilicus, and hence this is the best place to determine whether the organ is enlarged or pushed down lower than it ought to be; the fundus of the gall-bladder is situated just below the edge of the liver, about the ninth costal cartilage, outside the edge of the rectus muscle, but cannot be felt.

1. **Abscess of the liver,** though especially occurring in tropical countries, is not infrequent in higher latitudes. This fact is recognized when its alleged causes are considered, namely, dysentery, ulcers, or other gangrenous affections of the abdominal organs; phlebitis in the radicles of the vena porta, uterine phlebitis, also phlebitis in the systemic veins; operations such as those for hæmorrhoids and hernia; fractures of the cranium; embolism, worms, indigestion, the scorbutic cachexia, alcoholic poisoning, and heat.[2]

There are usually anatomical lesions of other organs, which we must take into consideration in order perfectly to understand the pathological anatomy of the disease and attain a clear insight into its nature; the most important and constant of these are found in the gastro-intestinal tract, the mucous membrane of which is usually the seat of exudation processes and ulcerations; in most cases these lesions are limited to the large intestines, and occasionally the lower portion of the ileum is also diseased; while in the upper part of the small intestines and in the stomach the only morbid appearances observed are slight hyperæmia and catarrh, and even these are by no means frequent occurrences.[3]

It is often extremely obscure in its origin and cause, it being impossible to detect its existence by the most patient study of symptoms and careful examination of the liver.[3] There is a class of cases[4] in which abscess may exist without any local symptoms or such general disturbance of the system as is commonly regarded as indi-

[1] L. Holden. [2] J. C. Davis. [3] Freirichs. [4] W. A. Hammond.

cating its presence, but associated with hypochondria and other evidence of cerebral derangement. In the more marked cases [1] the abscess is sometimes preceded by a perceptible falling-off in the general health, indicated by emaciation, dry cough and embarrassed respiration, loss of appetite, the complexion gradually assuming a muddy, sallow hue; but it more generally comes on in the midst of apparent health; the patient complains of a feeling of abdominal uneasiness, more particularly in the epigastric and hepatic regions, with some degree of fever, preceded by slight rigor or ague; but all these may be so slight as often to attract little attention. Pain [2] in the hepatic region is variable, sometimes constant, at others intermittent, or aggravated by movements of the patient, and by percussion and pressure; if the abscess is deep in the gland, very little, if any, pain will be felt; if near the surface of the organ, this pain is sharp and lancinating; it may be felt under the scapula and in the shoulder, but only in those cases where the abscess is superficial and near the convex surface; soreness or pain is found on pressure over that part of the rib nearest to the abscess; fluctuation is difficult to detect in most cases, but when present it is one of the most reliable signs of hepatic abscess. The general treatment should be quinine, acids, and such hygienic measures as will best enable the patient to withstand the suppuration.[2] In the obscure cases the abscess itself should be opened, by aspiration, at the earliest possible moment, and without waiting for adhesions to form between the liver and the abdominal walls.[3]

It is laid down as a rule [4] that in all cases of hypochondria or melancholia the region of the liver should be carefully explored, and even if no fluctuation be detected or any other sign of abscess be discovered, aspiration should be performed, as it is a harmless operation; the value of this treatment is illustrated in several cases in which cerebral disorder, with melancholia, were prominent symptoms, but in which other indications of hepatic abscess did not exist; aspiration was practiced successfully, pus being found in each, and recovery rapidly following.

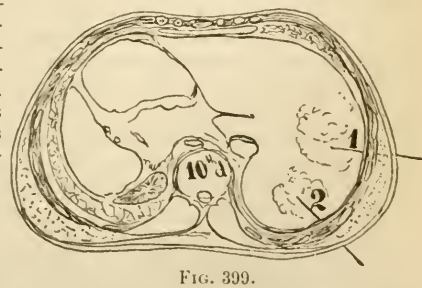


FIG. 399.

An exploratory puncture may be safely made in the eighth or ninth intercostal space a little posterior to a line drawn vertically from the middle of the right ax-

[1] Sir R. Martin. [2] J. C. Davis. [3] W. A. Hammond; J. C. Davis.
[4] W. A. Hammond.

illa, 1 (Fig. 399). If the trocar is used, proceed as follows:[1] The presence of pus having been established by exploratory puncture or fluctuation, the patient should be directed to assume the horizontal posture near the edge of the bed, or table, with the body projecting over the side if practicable. If the patient be timid, an anæsthetic should always be used. The skin is to be drawn aside over the site of the puncture, and the trocar thrust boldly in until the cavity of the abscess is reached; on the withdrawal of the trocar the pus will sometimes spurt out, at others, slowly trickle from the canula; the drainage-tube is now introduced into the cavity of the abscess through the canula; it is a good plan to use a coil, or long piece of tubing, and to mark the drainage tube at about eight inches from the end that is to be employed; the tube being in the abscess, the canula is withdrawn, and the tube cut off at the point designated; this simple procedure of dividing the tube after the canula is withdrawn will prevent the serious accident of the slipping of the drainage tube into the cavity of the abscess; the free extremity is now slit by a crucial incision; through the four ends threads are passed, the ends turned down and secured by adhesive strap to the skin, while the threads are each wound around strips of plaster and secured at a distance from the puncture; the abscess is now to be washed out with warm water, and after with a carbolized or iodide solution; a wad of carbolized lint is placed over the puncture, and secured by a loose bandage; the dressing must be renewed at least twice a day, the cavity thoroughly washed and dressed as before; the utmost cleanliness should be observed in all minor details.

In using the aspirating trocar, the proceeding is very much simplified;[2] wash out the cavity of the abscess with a carbolized or iodized solution, taking the precaution of having the patient assume different positions for a minute or two at a time, in order that the fluid may come in contact with every part of the cavity; this is important in order to get any benefit from the use of these solutions; the trocar should be of five or more inches in length, and of sufficient diameter to allow of the easy passage of shreds of connective tissue. The patient should be examined with care every day, and whenever the symptoms, such as pain, weight, or uneasiness in the hepatic region, or an increase in the volume of the liver, are noticed, the abscess must be again aspirated; if the abscess is progressing favorably toward a cure, the intervals will be lengthened, and the quantity of pus at each operation lessened; the number of times that puncture will be required is impossible to determine; an approximate idea may be formed by the quantity and character of the pus and the general condition of the patient.

When an abscess forms and presents under the margin of the car-

[1] Jiminez; J. C. Davis. [2] J. C. Davis.

tilages, it may be evacuated by aspiration or incision; the aspirator should be used when there is doubt as to the union of the liver to the abdominal walls, but if union has taken place an incision should be made along the margin of the cartilages of the ribs, the centre being over the most prominent point of the abscess (Fig. 352). The cavity should be cleansed with carbolic solutions, and free drainage should be maintained while the cavity closes.

2. **Gall stones** of large size may accumulate in the gall-bladder, or obstruct its duct, and cause severe and sometimes fatal results. In a well-marked case the following signs were present:[1] jaundice, intense itching of the skin, paroxysms of severe pain in right hypochondriac region: a tumor appeared which was continuous with the liver and filled the right hypochondrium, extending five inches and a half below the umbilicus, and having a transverse diameter of four inches and a quarter, measuring from the linea alba towards the false ribs; it was oblong, rounded, and slightly movable laterally; to the touch it was sensitive and hard, or tense; fluctuation was indistinct, but perceptible; aspiration proved the contents fluid. For the relief of this obstruction, cholecystotomy, incision of the gall bladder, was performed as follows:[1] The necessary antiseptic precautions, with carbolic spray and carbolic solutions for the hands, sponges, and instruments were taken. An incision was made (Fig. 352) three inches long, parallel with the linea alba, over the most prominent part of the tumor, about three inches to the right of the umbilicus; it commenced one inch above the umbilicus and extended two inches below that point; when the dissection exposed the peritoneum all hæmorrhage was carefully suppressed; the peritoneum was now divided, and a trocar introduced into the presenting tumor and the gall-bladder, and twenty-four ounces of fluid removed; the gall-bladder was now hooked up with a tenaculum and pulled to the outer edge of the incision, where it was seized with forceps and drawn out about two inches; its wall was then incised with scissors to the extent of about two inches, and its cavity cleaned; the edges of the cyst were united to the margins of the abdominal wound at its upper angle by fine carbolized silk sutures passed entirely through the abdominal walls, including the peritoneum; the lower portion of the abdominal wound was then closed by the same suture, and cotton wool with carbolized oil applied.

Death occurred on the eighth day from exhaustion due to hæmorrhages from mucous surfaces, owing to impairment of the blood by the biliary salts. The autopsy revealed complete union of the gall-bladder to the abdominal opening, without peritonitis.

[1] J. M. Sims.

II. THE SPLEEN.

The spleen lies on the left side beneath the ninth, tenth, and eleventh ribs, between two lines drawn vertically downwards, one from the anterior and the other from the posterior margins of the axilla; its upper edge is on a level with the spine of the ninth dorsal vertebræ and its lower with the spine of the twelfth; its position and size can only be recognized in health, and very imperfectly, by a certain dullness on percussion, but it cannot be felt unless enlarged; in proportion to its enlargement, it can be detected below the tenth and eleventh ribs.[1]

1. **Rupture of the spleen** generally terminates fatally by the effusion of blood into the peritoneal cavity, but recovery occasionally occurs when the lesion is limited and the effusion slight. Rest upon the left side, and the employment of cold, externally and internal, must be relied on to arrest hæmorrhage and prevent inflammation, with opium to secure relief from restlessness.

2. **Wounds of the spleen**, punctured, incised, and gun-shot, are commonly complicated with severe injuries of other organs; they are frequently recovered from, especially when there is a large external opening with protrusion of the organ. An important feature of these wounds is that they are not followed by a tendency to suppuration. Alterations of texture are limited to the immediate vicinity of the solution of continuity; there is little tendency to abundant pus formation, unless foreign matters are confined, and the bulky exudation products of inflammation are absent.[2] After shot injuries of the spleen the powerful muscular contractions seem to close the opening, and if this is not sufficient, coagulated blood fills the rest; in this manner the primary bleeding is soon arrested, and while the thrombosis advances into the injured blood-spaces of the spleen, a tissue consisting of spleen-tissue and blood-thrombi fills the shot channel, and finally forms a deep retracted scar.[3] The treatment depends upon the nature and extent of the wound; if slight, rest and cold must be relied on to control the hæmorrhage; if large, with protrusion of the spleen-tissue, the protruding portion must be ligated and cut away; this excision may be safely carried to the extent of removing the entire spleen, if damaged by the projectile. The spleen is withdrawn through the wound and a ligature applied to the vessels at the hilum.

3. **Hypertrophy of the spleen** may result from lukæmia, cystic degeneration, and other causes, and often attains enormous dimensions. The only remedial measure is extirpation, splenotomy. Although extirpation is very successful in wounds with protrusion, yet,

[1] L. Holden. [2] G. A. Otis. [3] Klebs.

when removed for disease, the operation has proved very fatal. There are two incisions by which the spleen may be removed, namely central, or lateral; the particular form selected must depend upon the size of the tumor: (1) Make an incision extending from three inches above the umbilicus to within three inches of the pubes; divide the peritoneum to the same extent; raise the omentum if it covers the spleen; while the organ is raised from its position, ligate the vessels in several parts; separate the attachments of the spleen, and remove it; the cavity must be cleansed and the wound closed.[1] (2.) Make an incision commencing below the ribs at a point corresponding to a line extending upwards from the anterior superior spine of the ilium, and curving downwards and forwards in front of the crest; open the peritoneum, break up adhesions, and turn the tumor out of the cavity; isolate the pedicle and tie it with a strong whipcord in four portions; tie bleeding vessels; return the pedicle to the cavity, and close the wound, 2 (Fig. 352).[2]

CHAPTER XLI.

THE ABDOMEN.

The abdomen is the largest cavity in the body, and is lined by an extensive and complicated serous membrane, the peritoneum: it extends from the diaphragm above to the levatores ani muscles below; the enclosing walls are formed principally of muscles and tendons, strengthened internally by a layer of fibrous tissue lying between the muscles and the peritoneum, the different parts of which are called the fascia transversalis, the fasciæ iliaca, and the anterior lumbar fascia.[3] The extent of the cavity, the relations of the enclosed viscera, and the peculiarities of the peritoneum, must be borne in mind in all operations upon the abdomen.

I. THE WALLS.

1. **Wounds** involving only the abdominal walls may be of every variety described. Simple, superficial, incised, and lacerated wounds are not dangerous. The treatment should be modified by their locality. In the epigastric region a wound is apt to gape on account of the proximity of the ends of the ribs; if the muscles are cut or torn on either side transverse to the direction of their fibres, attention should be more especially directed to the position of the body to relax those muscles. Wounds in the iliac regions may prove more formidable than they appear, owing to their penetration into

[1] T. Billroth. [2] T. Bryant. [3] Quain's Anatomy.

the vicinity of large arteries;[1] carefully clear the surfaces of all foreign substances, remove any lacerated tissue which might slough, arrest all hæmorrhage, by the ligature or torsion, and close the wound with closely-applied silver wire sutures taken at such depth as to firmly maintain the deeper parts in accurate apposition; relax the abdominal muscles by position, and apply long, narrow adhesive straps across the wound; complete the dressings with an evenly applied bandage around the body. If the wound involve the deeper tissues, especially the thicker parts, or wherever the muscles overlap each other, it will be found difficult to maintain perfect apposition of the whole cut, and hence there is a tendency to the accumulation of serous or sanguinolent fluids between the deeper surfaces, which are liable to induce foul suppuration.[1] If there is severe hæmorrhage, and the wound does not admit of the exposure of the bleeding vessel, enlarge it until the vessel can be seen and secured; hæmorrhage need not be feared while the wound is open and a finger can be placed on the bleeding point; never close the wound and trust to external pressure without securing the artery; suppuration should be prevented by proper disinfection of the wound with carbolic solution and the firm approximation, by the quilled suture, of the deep parts. If the wound penetrate the walls of the abdomen, the viscera are liable to protrude. In punctured and small wounds, a part of the intestine, omentum, or both, may escape, and are very apt to be constricted at their point of exit; in incised and lacerated wounds, larger portions of viscera may protrude, and without marked constriction.[1] The hands being disinfected, make a careful examination as to the nature of the protruded viscera, and the presence and adherence of foreign substances; if the protruded part is apparently omentum alone, ascertain that bowel is not concealed in the folds, or lying at the base of the protrusion; if it is healthy, being neither congested nor lacerated, it should be reposited within the cavity, the wound being sufficiently enlarged, if necessary, to admit of its return; but if the omentum is bruised, lacerated, dirty, inflamed, or congested, or if the mass be not considerable, but there is much resistance to its reduction, without enlarging the wound, pass a double thread through the base of the omentum and tie each half separately, then cut off all of the mass anterior to the ligature, and return the stump, allowing the ligature to depend from the wound; this ligature will separate in nine to fifteen days.[1] With the exception of the omentum, all other protruding viscera must be returned; intestines must be examined, and if there is no evidence of rupture or bruises, must be cleansed from dirt, hairs, or other matters, by means of tepid, disinfected water, and at once returned into the abdomen;

[1] G. Pollock.

great care and much gentleness are requisite in handling a portion of bowel when the reduction is attempted. Observe carefully the manner in which the coils of the bowels lie with regard to the wound, and commence manipulation with the portion last descended and nearest the margin of the opening, passing up portion after portion. If reduction is difficult, owing to the distention of the bowel by gases, press the air back, or, failing, puncture with an exploring needle, or better, with an aspirating needle attached to a pump or bulbous syringe,[1] and draw off the gases; if the difficulty arise from the smallness of the wound, enlarge it to the proper size without opening the peritoneum further, in the direction of the muscular fibres, and away from the course of the epigastric or other artery. If the bowel has long been strangulated, but is not gangrenous, return it at once; but if it is in a condition of gangrene establish an artificial anus.[2] It is desirable to close the wound at once; the parts around the wound must be relaxed by position; to secure uniform apposition of the edges, and maintain perfect support, silver wire sutures are to be preferred, and in their application the peritoneum should be included; the dressings cannot be too simple nor too light.[2]

Punctured wounds are more complex and dangerous, especially when they extend below the fasciæ of the abdominal muscles, for suppuration is liable to spread rapidly in the deep cellular tissue and between the layers of muscles; if the wound penetrates through the muscles, but not the peritoneum, it may prove fatal from peritonitis immediately supervening, or secondary to the suppurative stage; the suppurative action may spread at intervals, in various directions, and repeated abscesses form in different positions and cause death by exhaustion.[2] In treatment, first control hæmorrhage; if it is not sufficient to justify an enlargement of the wound in order to apply a ligature to the bleeding vessel, the outward flow should not be checked by external applications; if the hæmorrhage be at all free, the wound should be enlarged sufficiently to allow the bleeding vessel to be secured, no dependence being placed on pressure to restrain hæmorrhage; with the earliest suspicion of suppuration, open the wound freely to afford a ready escape to the blood, serum, or pus collected within.[2]

2. **Abscess** from injury may form in the connective tissue beneath the skin, or among the layers of the different muscles, or between the muscles and the peritoneum;[3] it may be due to perforation of the bowel, especially when it commences in the cellular tissue of the loin or iliac region, where it may be slow or rapid in formation, and must be distinguished from psoas abscess, tumors, hip-joint disease.[2] Deep abscess approaches the surface very slowly, owing to the interposed

[1] Davidson's. [2] G. Pollock. [3] S. D. Gross.

structures; the symptoms are rigors, severe pain, throbbing, an indurated swelling, with œdema of the cellular tissue, indistinct fluctuation until the pus is near the surface. The early treatment should be preventive; if pus is suspected, use hypodermic syringe to explore, and, if present, evacuate it by careful exploratory incision; if the abscess is very deep the pus will have a fæcal odor, though the bowels may not be injured.[1]

3. **Tumors**, fatty, fibrous, cystic, may form in the abdominal walls. In diagnosis, consider the history of each; examine the growth while the patient lies on the back, with thighs flexed and shoulders raised; if in the abdominal walls, it may be raised and the fingers passed under it; if the patient turns, the tumor remains fixed; but if intraperitoneal, it will float about loosely. In extirpation, make the incisions, as far as possible, in the direction of the muscular fibres; use the grooved director freely; tie all bleeding vessels as soon as divided; in closing the wound, unite carefully the muscular and then the tegumentary edges, so as to avoid the tendency to hernia; protect the wound by long and broad adhesive strips, a compress, and bandage.[1]

II. THE UMBILICUS.

1. **Hæmorrhage** is liable to occur in the new born, on the separation of the cord. If slight, it will be readily controlled by astringents, as by ferri persulph. or styptic cotton; if the flow continues, apply the nitrate of silver in stick. If these means fail, there is some congenital defect in the circulation of the liver which will probably prove fatal. The hæmorrhage in this case is to be controlled by passing a needle under the mass and surrounding it with a ligature.

2. **Morbid growths** may appear at the umbilicus, namely, fibrous tumors, wart-like bodies, and cancer; they should not be disturbed, unless they grow, when excision may be necessary. The cancerous tumor must be removed as follows: make two elliptical incisions in a line with the long axis of the body, which shall include the entire mass of disease; dissect carefully down to the linea alba, in healthy tissues, penetrate the linea alba, and cut around the tumor on a director; if the abdominal cavity is opened, carefully protect the intestines; close the wound with twisted suture with care passing the pins outside of the peritoneum; close the lips of the wound with fine interrupted sutures; secure the parts with adhesive plaster, compress, and bandage.[2] The antiseptic spray is very necessary, and antiseptic dressings should be applied.

[1] S. D. Gross. [2] W. Parker.

III. THE CAVITY.

1. **Ascites,** dropsy of the abdominal cavity, may result from many causes, as disease of the peritoneum, liver, heart; when the accumulation is so great as to cause inconvenience, the fluid may be safely evacuated by tapping the cavity. The best instruments for the operation consist of a trocar and canula, and a catheter closed at the end but perforated on the sides by numerous holes (Fig. 400).[1]

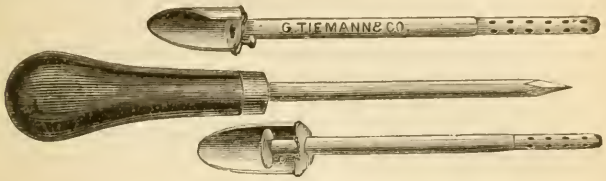


Fig. 400.

The trocar, in the canula, is thrust into the cavity, and then withdrawn, leaving the canula in position; the trocar being withdrawn, the perforated catheter is introduced; the fluid now flows without the possibility of obstruction by the prolapse of the omentum over the end of the tube, as always occurs with the old canula. Place the patient in a sitting position, or upon the side at the edge of the table; surround the body with a bandage sufficiently wide to cover the abdomen; tear the ends and make them overlap behind; take the trocar or needle in the right hand, the index finger being applied

Fig. 401.

to the shaft within an inch of the point; select a place two or three inches above the pubes, in the linea alba, and make an incision

[1] J. A. Wood.

through the skin with the point of the scalpel; through this incision, introduce the trocar, with a slight boring motion, until the extremity is free in the cavity; grasp the canula with the left hand, and hold it firmly while the trocar is withdrawn; push the canula farther into the cavity, and, if there is a perforated canula, introduce it into the open canula; while the fluid is escaping, assistants should gradually tighten the bandage behind; when the fluid is all removed, remove the canula instantly. Compress the edges of the opening with thumb and finger, and apply two long adhesive strips, crossing at the seat of puncture, and pin the bandage in place. If the fluid stops suddenly, before sufficient is removed, and no perforated internal canula is at hand, introduce a probe cautiously to dislodge any floating substance or omentum which may occlude the end of the canula. If the patient faint, arrest the flow by placing the finger over the opening while stimulants are administered (Fig. 401).

CHAPTER XLII.

THE HERNIÆ OF THE ABDOMEN.

The protrusion of any portion of the contents of the abdomen through an opening in its parieties is a hernia, and the varieties are named from the particular positions of their occurrence; as, umbilical, inguinal, femoral, obturator; the protruding part pushes before it the membranous structures it meets in its passage, and these furnish the coverings of the hernia.[1]

There are five rings (Fig. 402), or naturally weak points in the abdominal walls through which the contents of the abdomen may escape (Fig. 403), namely, the umbilical, 1; the internal and external inguinal, 2, 3; crural, 4, and the obturator, 5.

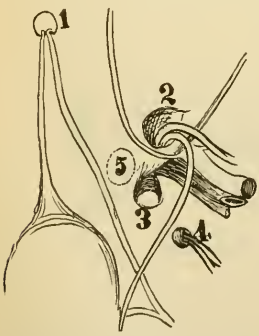


Fig. 402.

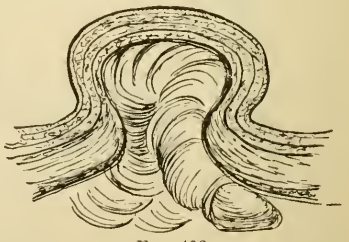


Fig. 403.

1. **The sac of a hernia** is the peritoneum, or the membrane first

[1] J. Leidy.

protruded. This is always a prolongation of the parietal peritoneum from the abdominal cavity.[1]

Its formation depends upon two different conditions, namely, either the vaginal process of the peritoneum already existed as a serous canal or sheath, making a congenital hernial sac, or it is formed by a slow and gradual process of relaxation, and a stretching, yielding, or elongation of the parietal peritoneum, due to the pressure of the viscus itself, which constitutes the hernia, making the acquired hernial sac.[2]

The sac consists of a body, or central part, above which is the neck, and below, the fundus.

At first, the peritoneum forming the neck and orifice is a plain membrane, puckered like the mouth of a closed purse, supported by the ring or canal which the hernia has traversed; next, these different peritoneal folds form adhesions together, owing to the prolonged contact of their serous surfaces; the connective and adipose tissues also seem to be transformed into a new covering, enclosing a large quantity of blood-vessels, the whole forming the induration of the neck of the sac of an old hernia, rendering it independent of the external fibrous ring; the orifice of the sac tends constantly to contract, and even become obliterated when the herniated organs cease to act upon it.[2]

2. **The contents of a hernia** consist of a part only of the abdominal viscera, and, in general, of those which are permitted by their peritoneal attachments to change their relative situations with the greatest freedom, as the small intestines and the omentum;[2] when the protruded viscera can be returned, the hernia is reducible; when they cannot, it is irreducible; if the irreducible is temporarily obstructed, it is incarcerated; if permanently obstructed, it is strangulated.

3. **The symptoms of hernia** appear in the following order: (1) there is a sense of weakness in the region in which a hernia commonly occurs: (2) fullness, especially if it is inguinal and the patient is erect; (3) a small tumor is felt, which is not permanent, but disappears under slight pressure or in the recumbent position and reappears when the pressure is removed, or in the erect position; (4) it becomes more prominent when the abdominal muscles act, or on coughing; or it may appear suddenly, as in infants, and after violent exertion in adults; the contents modify the signs thus: intestines give a soft, yielding, elastic swelling, resonant on percussion, if filled with gas, and dull, if filled with fluid; omentum is hard, resisting, and lobulated.[2]

4. **The diagnosis of reducible hernia** is generally very readily and correctly made; but when irreducible, or strangulated, the most experienced cannot always determine without the greatest care the precise nature of the complaint.[3] The most disastrous consequences have followed errors of diagnosis, and too much care cannot be taken

[1] J. Leidy. [2] J. Birkett. [3] S. D. Gross.

in distinguishing hernia from other affections of the region in which it appears. The diagnosis of hernia having been made, its management requires a greater combination of accurate anatomical knowledge with skill than most other surgical affections. Conditions threatening the extinction of life occur at times and in situations demanding prompt resolution and decisive action.[1]

5. **The truss** is the first appliance to be resorted to in reducible hernia; it should be applied immediately that the disposition to the formation of rupture is detected, with a view to procure adhesions of the serous surfaces; the rule applies to both sexes and all ages, the only exception being a misplaced testis;[2] the effect of such pressure is to approximate the sides of the mouth of the sac, prevent the descent of the bowel, and lead to contraction and final obliteration of the sac.

As the commencement of a radical cure by truss pressure dates from the last time the bowel or omentum came into the sac, it is of the first importance to prevent the hernia from ever coming down; you must not be content with seeing the patient stand when you fit a truss, but must make him sit on a low seat, then stand, walk, jump from a stool, to see if the truss completely retains the hernia; about fifteen to twenty per cent. may be cured by judicious and persistent truss-pressure.[3]

6. **Various operations** have been devised and performed with a view to the radical cure of reducible hernia. To be effectual and permanent they must obliterate the sac, close the ventral orifice, strengthen those weak parts in the walls of the abdomen through which the rupture protrudes, and improve the tone of the peritoneal ligaments of the viscera; they are adapted only to those cases in which the protruded viscus has descended into a patent vaginal process of the peritoneum; all other kinds should be rejected as unsuitable.[2]

These procedures have not accomplished the objects sought with that degree of certainty which belongs to legitimate operations, and while they hazard the life of the patient, the complaint is very liable to return, and the only protection against relapse is a truss.[4]

7. **An irreducible hernia,** not strangulated, should be treated with a view (1) to render it reducible; in small, recent hernia, direct the recumbent position, low diet, and antiphlogistic measures; (2) to prevent its increase; apply a spring truss with a hollow pad; (3) to relieve suffering; regulate the diet, bowels, and exercise.[5]

8. **The strangulated hernia** must first be examined with a view to determine its kind and variety; the duration; the hour at which vomiting commenced; the variations in the composition of the fluids ejected; the usual size of the tumor; its bulk before vomiting; the

[1] Sir A. Cooper. [2] J. Birkett. [3] J. Wood.
[4] W. Lawrence; T. Bryant; F. H. Hamilton. [5] S. D. Gross.

changes during this stage; the pain, whether local or extending into the abdomen with or without manipulation; the condition of its coverings; its probable contents; the treatment already pursued.[1] The first step in the treatment is to endeavor to displace the hernia from its abnormal position and pass it through the orifice of the sac into the peritoneal cavity. Proceed as follows: (1) Before vomiting occurs, abstain from manipulation of the tumor until other remedial means have been tried; place the patient on the back, with knees flexed and pelvis raised, and apply warm fomentations over the region of the mouth and neck of the sac, especially in children; support the tumor, and give a full dose of opium; if the patient cannot maintain the position, or it should be injudicious to enforce it, relax the abdominal muscles by allowing him to lie on the side, the tumor being carefully supported; if urgent symptoms do not arise, a few hours may be allowed to elapse to afford time for this treatment to take effect. The taxis must next be employed if reduction does not follow the use of the preceding measures; this is a method of manipulation and must be practiced as follows: place the patient in a position to relax all abdominal muscles which contract around the mouth of the sac, fixing as far as possible the mouth and neck of the sac with the fingers of one hand, whilst the fundus of the tumor is held in the palm of the other, the object being to dilate the mouth of the sac and diminish the bulk of the protrusion, the fact being borne in mind that irreparable injury is frequently inflicted upon the herniated bowel by violence, and that the danger of mischief by the use of the taxis increases in proportion to the length of time the bowel has been strangulated.

Other measures have been employed to assist in reduction, with occasional benefit, as purgative enema, which should not be repeated; reversing the trunk by keeping the head nearest the ground and the pelvis upwards; encircling the abdomen with a folded sheet and drawing the contents of the pelvic region upwards whilst the patient is in the recumbent position; but the uncertain result which attends the employment of these measures, the progressive disease, the risk to life of delay, should deter from the persisting in entertaining hope of reduction by taxis after its failure under the full influence of anæsthetics.[1]

(2.) During the stage of vomiting, cold may be employed over the mouth, neck, and body of the sac to retard inflammatory process, reduce nervous sensibility, and permit advantageous manipulation of the tumor; but it should be regarded only as a very useful prophylactic, as in cases where there is unavoidable delay in liberating the bowel from constriction, and is scarcely admissible as a rule when indications of strangulation have existed twenty-four hours, on account of the delay which must necessarily occur at this important moment. All other modes of treatment have now been abandoned in

[1] J. Birkett.

favor of anæsthetics which exert an influence over the causes preventing reduction more speedily, certainly, with less risk to life, and much more within control. In the administration of the anæsthetic, at this stage, have a distinct understanding with the patient that if the taxis fail the operation shall be immediately performed. As soon as the voluntary muscular contraction ceases, make gentle and well-preconcerted pressure, and, if the taxis succeed, the tumor will gradually become softer or less elastic, smaller and of different shape, until it escapes from the embrace of the mouth of the sac; taxis, if not already abandoned, must always be discontinued altogether when it is certain from the vomited fluids that there is regurgitation of the contents of the duodenum and jejunum.[1] The failure of the taxis necessitates the liberation of the hernia by a cutting operation, and the surgeon should be duly impressed with the indisputable fact that upon his discretion, firmness, and resolution now hangs the fatal issue, for each minute diminishes the chances of recovery.[1]

9. **The operation for hernia** involves, more or less, the following considerations: (1). The careful recognition of the characteristics of the tissues covering the sac, as they differ in the special regional varieties.[1] In recent hernia the cellular tissue and fat will differ little in appearance from the ordinary condition; but in old herniæ the structures between the skin and sac are likely to be much attenuated;[2] successive layers may often be raised, sometimes to the number of fifteen or twenty.[3] The sac, in many instances, cannot easily be distinguished from the cellular tissue over it;[2] and hence the following signs are useful: if the hernia is intestinal and not adherent, a sense of fluctuation may generally be detected at the inferior part, when the tumor is grasped;[4] the sac has a bluish vesicular appearance, and if a portion is pinched up between the thumb and forefinger, the opposite surfaces may be rubbed together, which cannot be done with any other tissue; or a needle may be introduced, and if a drop of serous fluid escape this will decide the question.[5] (2.) In a comparatively small number of cases, the hernia may safely be reduced by dividing the stricture external to the sac; and the question may be decided in each individual case as follows: divide the stricture external to the sac and reduce the mass, when the symptoms of strangulation have existed but a few hours, and are not very severe, the vomiting is not stercoraceous, the patient not very prostrate, the tumor is a simple enterocele, and has resisted forcible attempts at reduction; open the sac when strangulation has existed a long time, with inability to empty the sac, persistence of stercoraceous vomiting, prostration, and after repeated, protracted, or forcible taxis has

[1] J. Birkett. [2] Sir W. Fergusson. [3] F. H. Hamilton. [4] Sir A. Cooper. [5] S. D. Gross.

been used, or the hernia is an entero-epiplocele[1] or an epiplocele. 3. An examination of the contents of the sac to determine their condition and management. In all cases there will be more or less injection of the vessels of the protruded viscera; when the constriction has been slight, the color is nearly normal: but when severe or long-continued, it may be colored purple, or of blackish hue, with here and there a slight ecchymosis, and still not be gangrenous; if there is doubt, empty the vessels by pressure, and notice whether they again fill, or apply a cloth wrung out of warm water ten or fifteen minutes, and note the change in appearance, or puncture some of its vessels to obtain a flow of blood. Notice the softness, the sensibility, and the temperature.[2] Examine the omentum present, and return it, if healthy, but if it is gangrenous, or very bulky, cut it off near the mouth of the sac, apply ligatures to vessels, and when the hæmorrhage has ceased return it with its cut surface applied to the mouth of the sac and the ligatures suspended in the wound; if the omentum adhere to the sac, the adhesions may be cut through with considerable freedom, but the vessels must be carefully secured.[3] 4. Mortification of the intestine may be apparent before the operation by the pulse becoming full and soft, often intermittent with hiccup, freedom from pain, and less frequent vomiting: the tumor also becomes soft and doughy, the skin purple, the cellular tissue emphysematous and crepitant on pressure; the mortification may not be detected until the operation, when the intestine will be dark purple, with spots of a leaden color or greenish hue, loss of lustre from a film of brown adhesive matter.[3] The treatment in the first case must be by poultices to hasten separation, with supporting diet; in the latter case, (1) carefully divide the stricture without detaching the adherent intestine from the sac further than may be necessary; (2) make a firm incision into the whole extent of the mortified portion of the gut, and, as far as practicable, evacuate the gangrened intestine and the canal above; (3) if the gangrene is confined to a small spot, and the adhesion is neither firm nor extensive, replace all of the intestine except this weak point, but if the gangrene is extensive and adhesions firm, leave the intestine in the sac, keep the wound open, and apply poultices.[3] The restoration of the fæces to the natural passage will depend upon the loss which the cylinder of the intestine has sustained; if the opening is small, restrain the escape of fæces or food by the application of gentle pressure, and permanent closure will frequently occur; if the opening is large and shows no tendency to close, the only feasible operation consists in the destruction of the septum, eperon, by the enterotome.

[1] J. Birkett. [2] S. D. Gross. [3] Sir A. Cooper. [4] G. Pollock.

II. INGUINAL HERNIA.

This form of hernia consists in the protrusion of the abdominal viscera covered by the peritoneum, 15 (Fig. 404), in the course of the inguinal canal, 1, the channel, by which the spermatic cord passes through the abdominal muscles to the testis.

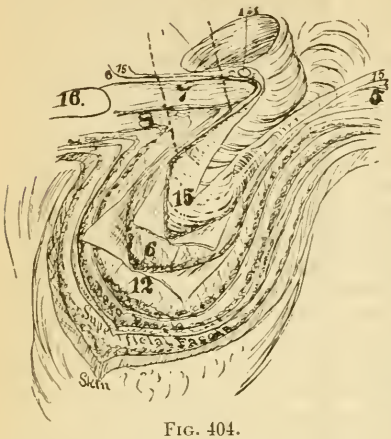


FIG. 404.

This canal begins at the internal abdominal ring, midway between the symphysis pubis and the anterior superior spine of the ilium, and ends at the external ring, half the distance from the internal ring to the symphysis, is two inches in length, and parallel with and immediately above the middle of Poupart's ligament; in front the canal has the aponeurosis of the external oblique muscle, in its whole length and at the outer end the fleshy part of the internal oblique, 5 (Fig. 404); behind is the transversalis fascia, 6 (Fig. 404), and toward the inner end also the conjoined tendon, 7 (Fig. 404) of the two deep abdominal muscles; below it is supported by the broad surface of Poupart's ligament, which separates it from the sheath of the large blood-vessels descending to the thigh, and from the femoral canal at the inner side of those vessels; the spermatic cord, composed of arteries, veins, nerves, and excretory duct, occupies the canal, and receives from the abdominal wall, as coverings, the cremasteric muscle (Fig. 404), the infundibuliform fascia, 10 (Fig. 404), and spermatic fasciæ, 12 (Fig. 404); the epigastric artery, 13 (Fig. 404), arising from the external iliac, accompanied by two veins, ascends under cover of the transversalis fascia, 6 (Fig. 404), along the inner side of the internal ring, close to the edge of the aperture, or at a short interval from it, the vessels of the spermatic cord being near, while the vas deferens, in turning from the ring into the pelvis, curves around it.[1]

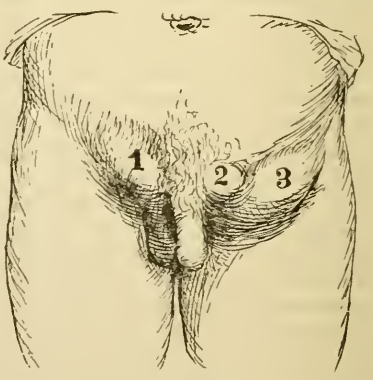


FIG. 405.

[1] Quain's Anatomy.

Herniæ in this region are oblique, 1, or direct, 2 (Fig. 405). Oblique hernia passes through the internal ring into the inguinal canal, forming a bubonocele, 1 (Fig. 405), then emerges from the external ring and enters the scrotum; the mouth of the sac is situated to the outer side of the internal epigastric artery, 13 (Fig. 404), and its neck and body are usually in front of the structures composing the spermatic cord (Fig. 406). The development of the sac differs essentially in respect of the age of the individual; namely, in infancy, youth, and early manhood, the disease is usually dependent upon the persistence of a serous canal, or sheath, in direct communication with the peritoneal cavity, which a portion of bowel or omentum may enter and form a hernia at any period of life; but in adult life the sac is a distinctly new formation, of slow development, and with progressive stages. Direct hernia, 2 (Fig. 405), merely traverses that small portion of the inguinal canal which lies immediately behind the external ring;[1] its path through the conjoined tendon is represented by the dotted line on either side of 7 (Fig. 404).

Fig. 406.

1. **The symptoms and appearances of inguinal hernia** are generally sufficiently characteristic, but even in the most marked case it is important, by a formal inquiry and the recognized tests, to distinguish it from different affections which occur in these organs and tissues.

The more noticeable are hydrocele, encysted spermatocele, connected with the epididymis; varicocele of the spermatic veins; inflammation of an old hernial sac and its results; inflammatory affections and other diseases of the testis, cord, and their coverings, of inguinal and lymphatic glands; hæmatocele; malpositions of the testis; growths of fat in the connective tissue of the inguinal canal and upon the spermatic cord; diseases of the integuments of the scrotum, especially growths.[1]

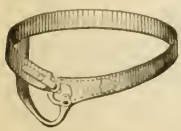


Fig. 407.

2. **The truss** selected for the early treatment of this hernia must be preventive and curative. It is of great importance to protect those who, from hereditary tendency or weakness of the abdominal walls, are predisposed to rupture.

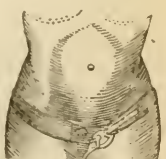


Fig. 408.

For this purpose a broad band with a suitable pad (Fig. 407) may be worn

[1] J. Birkett.

(Fig. 408). It should consist of stout elastic web, which passes round the body, and is attached to the pad in front by metallic loops engaging studs on the pad; elastic bands pass from the body band, under the limbs, to studs upon the rupture pads.

If the patient is corpulent, two pads (Fig. 409) should be used to give more extended support to the abdomen (Fig. 410).

If hernia exist and is reducible, a truss must be selected according to the size of the aperture; it should not press in the tissues, nor invaginate them into the canal between the pillars of the external abdominal ring, and thus stretch, fray, and weaken the intercolumnar fascia.[1]

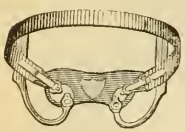


Fig. 409.

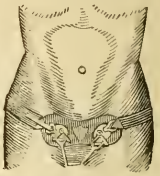


Fig. 410.

The bearing of the surface of the pad should be flat, the edge rounded off, the shape being an oblique oval. The best substance for the pad is vulcanite, and it should be maintained in position by a side-spring which encircles the body midway between the trochanter and the anterior superior iliac spine; sometimes it is necessary to wear a perineal band which buttons in front, but this may be dispensed with when the truss has accommodated itself to the shape of the body.[1] A great variety of trusses may be found, but unless they conform in construction to the principles given they will fail to meet the indications. The several instruments most worthy of consideration are (Fig. 411):—

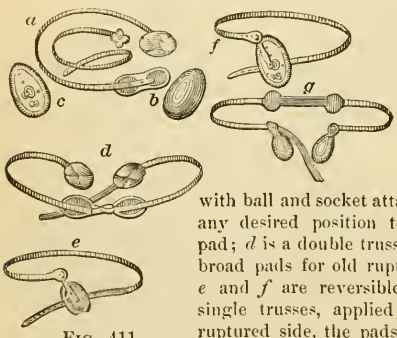


Fig. 411.

a, the single truss, adapted to adults or infants; *b* is the convex pad with ball and socket attachment; *c* is a convex pad with ball and socket attachment, and set screw for giving any desired position to the pad; *d* is a double truss with broad pads for old ruptures; *e* and *f* are reversible pad single trusses, applied from ruptured side, the pads having a sliding-arm attachment secured by a set screw; *g* is a double truss of same kind. The application of the truss (Fig. 412) requires the spring to be passed across the body from the well side, and the longest diameter of the adjustable pad to be placed in the line of rupture.

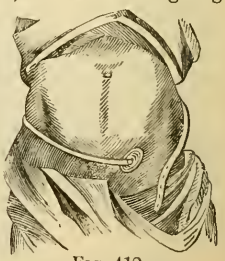


Fig. 412.

To prevent undue pressure upon the cord, which may be so great and long-continued as to cause atrophy of the testicle, a pad has been devised[1] with a slit or chink (Fig. 413), which gives a horse-shoe shape, the shorter end lying upon Poupart's ligament, immediately outside and above the spine of the pubis, the

[1] J. Wood.

longer end lying on the inner pillar; the inner border of the pad being parallel to the outer edge of the rectus muscle, while the round part presses upon the internal ring, and the movable cord slips into the chink between the two points of the pad, and escapes all injury.

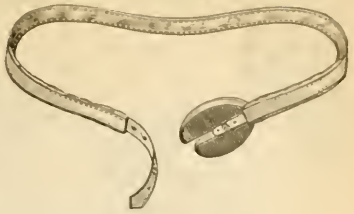


Fig. 413.[1]

3. **The radical cure** may be determined upon in some cases, and the following method is then advised:[2]—

(Fig. 414.)[3] Place the patient on his back, with the shoulders raised, the knees bent, the pubes shaved, the rupture reduced, and give an anæsthetic; make an incision about an inch long in the skin of the scrotum, over the fundus of the hernial sac; carry a small tenotomy knife flatwise under the margins of the incision, so as to separate the skin from the deeper coverings of the sac to the extent of about an inch, all round; pass the forefinger into the wound and invaginate into the canal the detached fascia and fundus of the sac. The finger now feels the lower border of the internal oblique muscle, which must be lifted forwards to the surface; by this means the outer edge of the conjoined tendon is felt to the inner side of the finger. Carry a stout semicircular needle, mounted in a strong handle, with a point flattened antero-posteriorly, and an eye in its point, carefully up to the point of the finger along its inner side, and transfix the conjoined tendon and the inner pillar of the external ring, when the point is seen to raise the skin, draw the latter towards the median line, and make the needle pierce it as far outwards as possible; hook into the needle a stout copper wire, silvered, about two feet long, draw it back into the scrotum, and detach: next place the finger behind the outer pillar of the ring; raise that and Poupart's ligament as much as possible from the deeper structures; pass the needle along the outer side of the finger, through Poupart's ligament a little below the internal ring, and through the skin puncture made before; hook the other end of the wire to the eye, draw it back into the scrotal puncture, and detach; pinch up the sac in the wound with the finger and thumb, forcing the cord backward, and pass the needle across behind the sac, entering and emerging at the opposite ends of the scrotal incision; hook the end of the inner wire on the needle and draw it back across the sac and detach; now draw down both ends of the wire until the loop is near the surface of the groin above, then twist them together down into the incision, and cut off to a convenient length. Traction on the loop invaginates the sac and scrotal fascia well up into the hernial canal; twist the loop of wire down close into the upper puncture, bend it down to be joined to the two ends in a bow or arch, under which place a stout pad of lint, and secure the whole by the spica bandage; retain the wire from ten to fifteen days, or longer, according to the consolidation; untwist and withdraw upwards.

Fig. 414.

[1] G. Tiemann & Co. [2] J. Wood; T. Bryant; T. Holmes. [3] T. Bryant.

It has been reported [1] that a radical cure may be easily effected by exciting the inflammation in the tendinous tissues about the ring, by the injection of a few drops of a solution of the fluid extract of quercus alba, and morphine, in the proportion of ℥i. of the former, to gr. ss. of the latter, into those tissues.

4. **Strangulated oblique inguinal hernia**, which has resisted well-directed taxis, while the patient is fully anæsthetized, must be at once liberated by division of the stricture.

The coverings are (Fig. 404): (1) skin, (2) superficial fascia, (3) intercolumnar fascia, (4) cremaster muscle, (5) infundibuliform fascia, (6) subserous cellular tissue, (7) sac.[2] The anatomical points to be particularly sought are (1) the external ring, (2) the aponeurosis of the external oblique muscle, (3) the internal ring, (4) the mouth of the sac; and the length of the incision should be just sufficient to expose freely these anatomical parts.[3]

This operation should be performed with careful attention to all of the details required in the use of antiseptic dressings, Provide an ordinary hernia knife [4] (Fig. 415), a common scalpel, probe-pointed bistoury, forceps, director. carbolized sponges, carbolic water 1 to 20, and a hand or steam spray apparatus, and carbolized gauze. Place the patient on a firm low table; shave the parts and wash them with carbolized water; give the anæsthetic fully; raise the shoulders, and slightly flex the thigh of the affected side. The spray being steadily directed to the region about to be exposed, make an incision through the skin over the neck and body of the tumor, its upper extremity being nearly midway between the anterior superior spinous process of the ilium and the tuberosity of the pubes, about one inch and a half above the level of Poupart's ligament, and its lower about the middle of the scrotum (Fig. 416).[5]

Fig. 415.[6]

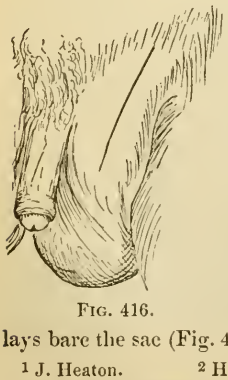


Fig. 416.

Or, with the aid of an assistant, raise a fold of integument, pass a sharp-pointed bistoury through its base, and cut it outwards (Fig. 417).

This incision exposes the intercolumnar fascia which forms the first and thickest covering of the sac; divide this by raising with forceps (Fig. 418) or on a director, when the cremaster muscle will be exposed, which must be cut in a similar manner, and this incision lays bare the sac (Fig. 419). The division of these layers often causes

[1] J. Heaton. [2] H. Gray. [3] J. Birkett. [4] Sir A. Cooper.
[5] Sir W. Fergusson. [6] G. Tiemann & Co.

great embarrassment and delay, for the operator, expecting to see the sac itself, when he has divided the integuments, mistakes this thickened covering and the cremaster muscle for the hernial sac, and cuts the fascia with extreme caution, fibre by fibre.[1] Open the sac with exceedingly great care, to avoid including the walls of the bowel, either seizing the sac with forceps (Fig. 418), or raising it between the thumb and fingers. Make an opening sufficiently large to admit a grooved director with the scalpel, the sharp edge of which is directed laterally, the side of the blade being placed nearly flat on the

Fig. 417.

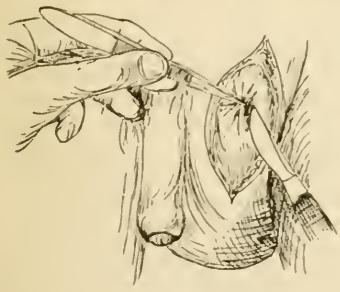


Fig. 418.

Fig. 419.

tumor; divide the sac on the director, pressed firmly against its inside[2] (Fig. 419). If the intestine is connected with the sac by adhesions, an extraordinary amount of caution is required in opening the sac, as it contains little or no fluid; [1] next, pressing the finger upon the sac, insinuate it through the external inguinal ring, to ascertain if there be any structures which firmly encircle the neck and orifice of the sac outside; if any are found, introduce a grooved director underneath, and cut them; make slight pressure upon the sac to return its contents into the abdomen; if reduction be impracticable, open the sac sufficiently to reach its orifice easily: pass the index finger along the anterior surface of the protrusion upwards towards the mouth of the sac, when the stricture will be encountered; the

[1] Sir A. Cooper. [2] J. Birkett.

palm being upward, pass the hernia-knife flatwise along the finger (Fig. 420), or on a grooved director, through the mouth of the sac; turn the knife so as to cut parallel with the linea alba, and divide the structures in contact with it sufficiently to allow the ungual phalanx to pass freely into the abdominal cavity.[1] Carefully examine the protruded intestine to determine whether the brown color which it assumes under strangulation lessens or disappears, the proof of a return of circulation; the intestine should also be pulled down a little to examine the part immediately compressed by the stricture; the veins on the surface may be emptied by pressure, and their sudden filling noted; if the intestine appears to have free circulation, relax the parts by position, and directly but gradually return it, replacing about an inch at a time, and securing each part with the fingers until the whole is returned into the abdomen. The contents of the hernial sac should be exposed to the carbolized spray, and then returned; all violence and improper haste should be guarded against, for the intestine is tender, and will easily tear at the strictured part.[2] Clear the parts of blood, and having nicely adjusted the sac and its coverings introduce a drainage tube; now bring the edges of the wound together, and retain them by sutures; the needle and ligatures should be passed through the integuments only, great care being taken to avoid penetrating the sac; apply a piece of lint, and over it a compress with a T-bandage, so as to close the orifice of the sac; while the patient is being carried to his bed, support the wounded part with the palm of the hand.[2] Or antiseptic dressings may be applied so as to fill the groin, and be supported by the gauze bandage applied around the body, and as a spica to the thigh.[3] The important feature of the after-treatment is the diet, which should be farinaceous, with milk; opium should be used when required; the bowels are often relieved spontaneously, but if they remain inactive, and any discomfort arises, give an enema of warm water, or gruel with common salt, or a little castor-oil; if thirst is distressing, give ice; stimulants are often required soon after the operation, but should be given in small quantities, and the addition of thirty drops of laudanum is frequently very useful.[1] If, instead of rapid union, the connective tissue, the wound, the omentum, or the hernial sac in-

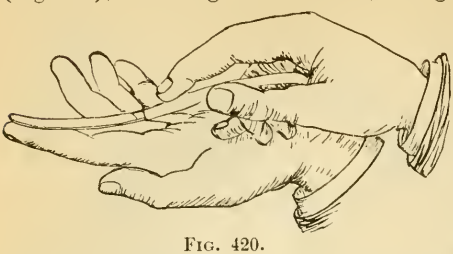


FIG. 420.

[1] J. Birkett. [2] Sir A. Cooper. [3] J. Lister.

flame, remove the lower suture, or all of them, to secure free drainage, and adopt the treatment for inflamed, suppurating, or sloughing wounds.[1] Thorough disinfection of the wound at all stages by carbolic acid solutions is most important. If the sac contain both omentum and intestine, the former will be in front, and when omentum is found search should be made to ascertain if there is not a small knuckle of intestine behind.[2]

Omentum is much less capable of resisting the effects of inflammation than intestine, and is frequently not in a condition to be replaced when the latter is; when inflamed, the omentum is less discolored than the intestine, and loses its consistence, and if the tests applied to the intestine prove feeble circulation, the omentum should be excised: it should also be excised when much enlarged by intestinal deposits, or liable from its bulk to excite peritonitis.[3] If there are recent adhesions, carefully disengage the intestine with the finger or handle of the knife; but if they are short, and the intestine and sac are agglutinated by old adhesions of limited extent, cut off redundant portions of the sac, and return the remainder still adhering to the bowel. Adhesions at the mouth of the sac are separated with extreme difficulty, dilate the wound to the point of attachment; slit up the tendon of the external oblique; if convolutions are glued together, separate them.

5. **Direct inguinal hernia**, 2 (Fig. 405), 14 (Fig. 404), (Fig. 406); forms slowly, appearing first as a prominence behind the external ring, and having a more globular shape than the oblique: the finger enters the abdominal cavity more readily, and on the outer side of the orifice of the sac the internal epigastric artery, 13 (Fig. 404), is felt pulsating; it traverses only that small portion of the inguinal canal which lies immediately behind the external ring, and pushes before it or lacerates the conjoined tendon, 7 (Fig. 404), and the pubic portion of the internal abdominal or transversalis fascia, 6 (Fig. 404);[1] it is inclosed between the epigastric artery, edge of the rectus, 16 (Fig. 404), and Poupart's ligament.[4] The truss for this hernia should have a flat, rounded, or oblately oval pad fitting closely between the edges of the rectus and Poupart's ligament, reaching well down to the crest of the pubis, and provided with a slight notch below for the passage of the cord.[4] In strangulated direct hernia, when the taxis is used, direct the pressure upwards and inwards, instead of upwards and outwards.[5] If an operation becomes necessary for relief, make an incision through the integuments along the middle of the tumor from its upper to its lower part; divide the fascia, which brings into view the sac; the stricture should now be sought for, and, whether found at the external ring, or higher up, or within the sac, divide it directly upwards, to avoid the epigastric artery.

[1] J. Birkett. [2] F. H. Hamilton. [3] S. D. Gross. [4] J. Wood. [5] Sir A. Cooper.

II. FEMORAL HERNIA.

In this hernia the bowel leaves the abdomen at the groin, under the margin of the broad muscles and upon the anterior border of the hip-bone, immediately at the inner side of the large femoral blood-vessels; after passing downwards about an inch or less, it turns forwards to the fore part of the thigh, at the saphenous opening in the fascia lata, where the swelling may be felt and seen.[1]

The first symptom is pain about the stomach, causing nausea on straightening the thigh, relieved on taking the recumbent position and elevating the knees; the first distinct external mark is a general swelling of the part, easily reducible by pressure, descending in the erect and ascending in the recumbent posture; next a small circumscribed tumor appears, the size of the finger's end, under the crural arch, about an inch on the outside of the tuberosity of the pubes, in the hollow between this process and the crural artery and vein (Fig. 421). As the tumor enlarges it passes forwards, and often turns over the anterior edge of the crural arch; the swelling now increases more laterally so as to assume an oblong shape, the longest diameter being transverse, 3 (Fig. 405); in the female it is generally very movable, and, being soft, resembles a gland: it appears in the erect and disappears in the recumbent posture, dilates when the patient coughs, is elastic and uniform when it contains intestines, and gives a gurgling noise when it returns into the abdomen; when it contains omentum the surface is less equal, it feels doughy, and gives no particular sound on reduction.[2] Femoral must be distinguished from inguinal hernia by its position below Poupart's ligament (Fig. 405); from abscess; from an enlarged gland and an enlargement of the femoral vein; from tumors at this point.[2]

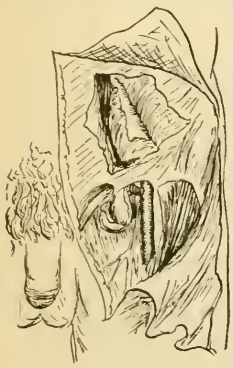


Fig. 421.

The treatment of simple hernia must be by a well-adjusted truss; the truss pad must protect the crural ring by pressure over Poupart's ligament, and must also press upon and fill the saphenous opening, without pressing downward so as to obstruct the saphenous vein. The best form of truss pad is egg shape, with the small end downwards, and adapted to the shape of the saphenous opening, but rather longer, so as to press upon Poupart's ligament with its broad end above; the side spring is exactly in the centre; the pad end of

[1] Quain's Anatomy. [2] Sir A. Cooper.

the spring is bent downward in a large curve, to permit the patient's thigh to bend freely. The irreducible hernia is best supported by a truss with a hollow pad so arranged as to receive the mass.[1]

When strangulation occurs, time is of immense consequence, as mortification occasionally takes place in less than twenty-four hours from the attack. First employ taxis, as follows: Give an anæsthetic, and then place the patient on the back; elevate the head, shoulders, and pelvis; flex the legs upon the thigh, and the thighs upon the body, and rotate the affected thigh strongly inwards; draw the tumor downwards and slightly inwards, to efface the angle which it forms with the femoral canal, and bring it opposite the external ring; now push the parts directly backwards, to get them out of reach of the lunated edge of the ring; next make the pressure in an upward direction.[1] If taxis fail, proceed to operate. The coverings of a femoral hernia are: skin, 1 (Fig. 422), superficial fascia, 2, cribriform fascia, 3, crural sheath, the septum crurale, subserous areolar tissue, sac.[2] Select a scalpel, director, and hernia knife. The patient being placed on a suitable table, and anæsthetized, empty the bladder, and proceed as follows: Make an incision down to the superficial fascia from an inch and a half above the crural arch, in a line with the middle of the tumor, downward to its centre below the arch, 1 (Fig. 423); make a second incision from the inner across to the outer side of the tumor, 2, or 3, so that the form of the double incision shall be somewhat crucial (Fig. 423); divide the superficial fascia, which in recent hernia is very thin and may escape notice, or in very large hernia may be inseparably united to the fascia propria, cribriform, or deep fascia; the latter must not be mistaken for the sac; divide this fascia longitudinally from the neck to the fundus of the sac and expose the layer of fat between the fascia propria and the sac, with the director on which the entire sac is laid open; introduce the finger gently into the sac, between the intestine and its anterior part, on which carry the hernia knife into the crural sheath; divide the sheath as far as the anterior edge of the crural arch, or Poupart's liga-

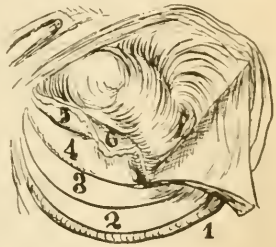


FIG. 422.

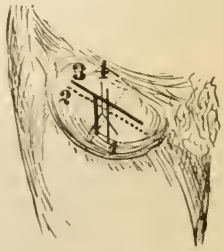


FIG. 423.

[1] S. D. Gross. [2] H. Gray.

ment, a distance not exceeding half an inch in a small hernia; if the intestines, when slightly compressed, cannot be readily emptied, the finger must be passed at least half an inch higher under the posterior edge of the crural arch and the fascia tranversalis, and the knife, carried within the stricture, must be inclined obliquely inward and upward, at right angles with the crural arch; divide the stricture in that direction sufficiently to liberate the intestine and admit of reduction. In very large herniæ it is advisable to divide the stricture external to the sac, but in small herniæ the risk of gangrene is such as to render opening the sac necessary; if the intestines adhere to the sac, separate them with great caution with the finger, or if the adhesions are short and very firm, portions of the sac must be cut away and returned into the abdomen with the intestine, to which they adhere, and the stricture must also be divided with great care, fibre by fibre. The after treatment is the same as for other hernia.

If the omentum has adhesions, break them down with the finger, and if more has descended than can be easily returned, or if it has become hard and knotty, cut it off through the sound part, which will be known by the bleeding vessels;[1] ligate the vessels, and return the mass only to the mouth of the sac; when the protruded parts have been returned, close the wound with sutures and adhesive plaster, and apply antiseptic dressings with suitable compress (Fig. 424).

Fig. 424.

The only possible danger which can be met with in the deep incision is an abnormal distribution of the obturator artery, which, if it arise from the epigastric artery, and wind close to the inner side of the neck of the sac, might be divided, and give rise to troublesome hæmorrhage; as it is impossible to ascertain the presence of the vessel in that position beforehand, and as it is seldom damaged by the cautious use of the knife, its existence may be ignored in practice.[2]

III. UMBILICAL HERNIA.

This form of hernia occurs at the point where the umbilical vessels pass through the abdominal wall; it exists anterior to the period when cicatrization is complete, which varies in different infants, but in general requires several months.[3] When the parts which fill the aperture are firmly cicatrized, this point of the wall is firmer than surrounding parts,[4] owing to the condensation of the cicatrix and the peculiar arrangement of the fibres of the transversalis fascia[5] (Fig. 425).

In infants the protruding viscus pushes before it that portion of the parietal

[1] Sir A. Cooper. [2] C. Heath. [3] W. Lawrence. [4] A. Scarpa. [5] Frorieps.

peritoneum lying immediately behind the aperture in the linea alba, through which the umbilical vessels enter the abdominal cavity; the hernial sac thus formed, before the closure of the ring is effected, may pass into the connective tissue of the cord itself before that structure has separated; after the separation of the cord the hernial sac may be protruded in consequence of the umbilical aperture remaining imperfectly closed, when it is covered only by the integuments; in the youth the hernia may escape through a partially closed ring, which it dilates by continual pressure; in the adult the fibres of the linea alba may become separated by stretching, owing to the pressure within, and the hernia escape at the site of the once closed ring, or in its vicinity (Fig. 425).[1]

FIG. 425.

The hernia begins by forming a soft, projecting, ovoid tumor at the navel; it may be reduced by pressure, when a small hole is felt with very sharp and rigid edges; if the finger is removed the skin either remains relaxed in the fossa of the navel, or is slowly projected forwards; as the disease progresses, the protruding viscus descends lower and lower, so that the broadest part lies below the mouth of the sac; the tumor varies much in form, the transverse diameter being sometimes greater than the vertical; occasionally it is pyriform, and seems suspended by a stalk, or spread out like a mushroom; again, its base is nearly as large as its body; in infants the hernia usually contains intestines, but in the adult omentum is generally added, and sometimes the stomach; the coverings, usually very thin and often inseparably united, are the integument, some fat, the internal abdominal fascia, the sac; the body of the sac is usually very delicate, but stronger near and at its orifice, around which the tissues form a firm, resisting, unyielding band; the mouth of the sac is often large, in proportion to the bulk of the protrusion.[1] This hernia has been overlooked in very corpulent persons, and proved fatal by strangulation.[2]

In the infant, persistent efforts must be made to close the opening by the following dressing: Apply a flat pad of any soft and tolerably firm material, moulded to the shape of the parietes, and extending beyond the margin of the opening (Fig. 426); maintain it in position by adhesive strips, or by a broad elastic band properly padded; remove the apparatus frequently to preserve cleanliness and prevent chafing, the finger being applied meantime to the opening.[3] Radical cures have been effected by operations.

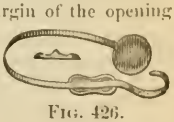


FIG. 426.

In the adult this hernia is best retained by a truss, with a wooden block slightly convex on its abdominal surface, and secured to an elastic spring encircling the body; if the hernia has become irreducible, apply a hollow, cup-

[1] J. Birkett. [2] S. D. Gross. [3] T. Holmes.

shaped, well-padded truss.[1] Obstruction from accumulation of stercoraceous matters frequently occurs in irreducible umbilical hernia, with severe constitutional disturbance, but without positive strangulation; this condition is best overcome by the free administration of aperient enemeta.[2] The radical cure has been effected as follows: Press the finger into the umbilical opening, and introduce the nozzle of a hypodermic syringe (Fig. 427) filled with fl. ext. quercus alba, and inject a few drops. In moving the point so as to distribute it around the neck of the sac, no harm is done if a small quantity of the contents gets into the sac;[2] retain the hernia surely in its place by a pad and bandage.[3]

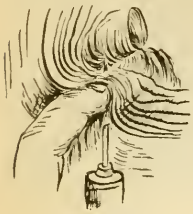


Fig. 427.

When strangulation occurs, too much stress cannot be laid upon the protracted and judicious employment of taxis, owing to the great fatality of operation upon this hernia; place the patient on the back; give an anæsthetic; as the tumor has descended, if at all bulky, draw it away from the ring, press its contents directly upwards, or upwards and backwards in a direction opposite to that of the displacement; should the taxis fail, and the symptoms not be urgent, try the effects of a full anodyne and cold or warm applications.[1] These efforts having failed, proceed to operate antiseptically: Select a scalpel and director; bearing in mind the thinness of the external coverings, particularly in recent cases, make a ⊥-shaped incision (Fig. 428), the vertical limb being carried nearly an inch above the upper extremity of the tumor, directly in the line of the linea alba; raise successive layers on the director down to the sac, which must, if possible, be left intact, owing to the great danger of fatal peritonitis, if it is divided. Seek the seat of stricture, which is generally found at the upper margin of the ring; carry the knife upwards upon the finger, and divide the stricture to the requisite extent; draw the protruded parts somewhat downwards, to liberate them from their confinement, and gently replace them into the abdomen, — first bowel and then omentum; if the constriction is within the sac, the latter must be opened, the incision being as small as possible; when the hernia is irreducible, leave the protruded structures, after the division of the stricture, in their extra-abdominal situation.[1]

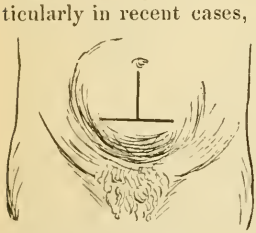


Fig. 428.

[1] S. D. Gross. [2] J. Birkett. [3] J. Heaton.

VIII.

THE RESPIRATORY ORGANS.

CHAPTER XLIII.

THE NOSE; THE NASAL FOSSÆ; THE ANTRUM.

I. THE NOSE.

Rhinoplasty,[1] the operation for restoring the nose, consists in the transplantation of healthy skin from one part and its adaptation to the formation of the new organ; this process involves making a new scar; the new skin has been taken from the patient's arm, hand, face, and forehead. The latter point, being most accessible, is generally preferred, though the pedicle is necessarily long, and must be subjected to considerable strangulation, in consequence of which sloughing very often occurs. The rules which should be observed, in performing the operation, are as follows:[1] (1) The patch should be taken at such an angle as will diminish as much as possible the twisting of the pedicle; (2) the patch should be placed upon a raw surface; (3) the exposed space from which the patch is removed should be covered in part by the flap raised for the patch.

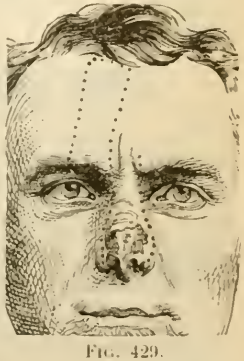


FIG. 429.

In general, the results of the operation are not satisfactory, owing to the tendency of the new nose to shrivel and collapse; nor have the ingenious methods of supporting the central part, as by a flap from the upper lip, or transplanting a terminal phalanx of the finger,[2] proved of great value. If, however, it is determined to undertake an operation the various steps to be taken are narrated in the following cases: —

1. **Restoration of the apex nasi** (Fig. 429).[1] The anterior edges of what remained of both alæ were pared and made straight; an incision was next carried upwards on both

[1] G. Buck.

[2] Hardee.

sides of the nose, on a line continuous with those edges to the inner extremities of both eyebrows; the included skin was dissected off the nose, and left attached above: an oiled silk pattern of the denuded nose was laid on the forehead, and a larger patch dissected up and turned edgewise on its pedicle, and applied to the exposed surface by sutures along the margins, special care being taken to allow no strain on its attachments; the patch of skin taken from the nose was applied to the lower part of the denuded surface on the forehead. The union of these flaps left prominent tubercles at the fold of their pedicles (Fig. 432); these were removed by curved incisions carried half around at the base of each on its broadest side, unfolding the skin and cutting away the redundant mass (Fig. 432). Union of these relieved the deformity.

2. **Closure of an opening into the superior meatus of the right nasal fossa**[1] (Fig. 430);—the skin at the margin of the opening was dissected up and everted with great care, owing to the thinness of the tissues; a pattern of the opening was laid on the forehead and a patch dissected up, *b*, *a*, *c*, having its base in such position as to avoid too much twisting when transferred; a strip of skin, *c*, *d*, intervening between it and the opening was dissected to make room for the patch, but was left attached above the right eyebrow and used to cover the space made by the flap; the patch was fixed by sutures, and warm-water dressings applied. Union took place except at the inner canthus; this was closed at a second operation by raising the edges of the skin and uniting them by sutures.

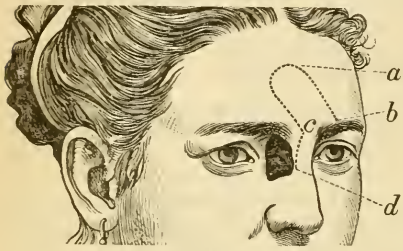


Fig. 430.

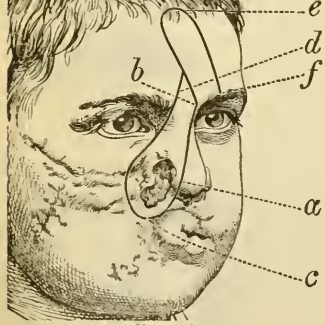


Fig. 431.

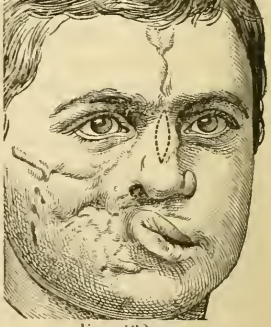


Fig. 432.

3. **The closure of a foramen** (Fig. 431) of the size of the finger has been accomplished by paring the edges of the opening and everting them; next, an

[1] G. Buck.

incision was made from *a* to *b*, and a corresponding incision on the opposite side; the included skin was dissected up and removed, but should have been reserved to cover the space on the forehead; the pattern of the space to be filled was laid on the forehead, and a flap, *f*, *e*, was dissected up, twisted on its pedicle, and applied to the surface exposed. The result was good (Fig. 432). An elliptical patch was next taken from the elevated mass caused by the pedicle; next, the mouth was made more symmetrical by extending the angle farther towards the cheek by the method given (Fig. 307). The result was favorable (Fig. 433).

FIG. 433.

The transplantation of patches dissected up with the periosteum adherent has been recommended,[1] for the purpose of elevating a depressed nose. This operation[2] consists in dissecting from the dorsum of the nose two flaps by an incision along its centre, and transverse incisions at either extremity; the next step is to dissect from the forehead a patch which will cover the denuded surface, removing with it the periosteum; this flap is then turned over upon the exposed surface with the integument towards the nasal fossæ, and the periosteum upward (Fig. 434); the two lateral flaps are then laid upon the raw surface of the reflected patch and united in the median line.

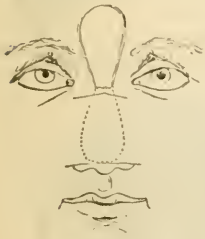


FIG. 434.

II. THE NASAL FOSSÆ.

The nasal fossæ open widely to the air in front through the nostrils, and behind into the pharynx.

The floor is horizontal, but the roof slopes forwards and backwards from the cribriform plate, making the vertical depth greatest in the middle: the outer walls are made irregular by the passages which the turbinated bones create, and numerous openings leading to the air cells; the meatuses, or passages, are three in number; namely, superior, middle, and inferior; the septum is formed chiefly by the perpendicular plate of the ethmoid and vomer.[3]

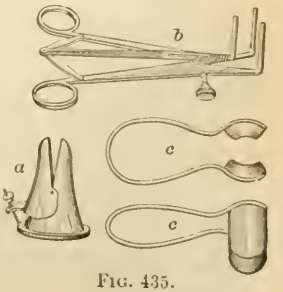


FIG. 435.

[1] L. Ollier. [2] L. Verneuil. [3] L. Holden.

1. **Exploration** of the fossæ may be made by inspection and palpation. Inspection, or rhinoscopy, may be anterior or posterior. For anterior inspection, select a speculum *a*,[1] *b*,[2] *c*[3] (Fig. 435) adapted to the case; place the patient in a good light, or use artificial light, introduce the speculum and dilate its branches.

The parts which can be seen are the interior of the nostrils, the anterior portion of the turbinated bone, a portion of the middle concha, and a portion of the floor and septum of the nasal cavity; if the meatus is large the posterior wall of the pharynx and even the orifices of the Eustachian tubes may be observed.[2]

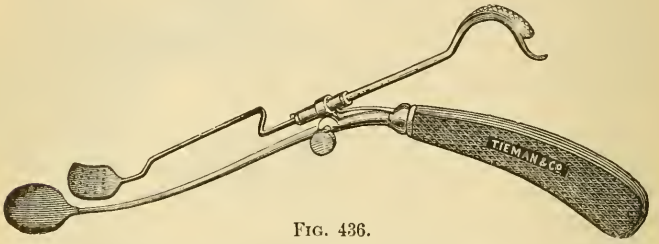


FIG. 436.

For posterior inspection (Fig. 437), select a suitable spatula and mirror (Fig. 453), or the rhinoscope (Fig. 436)[4]; the patient

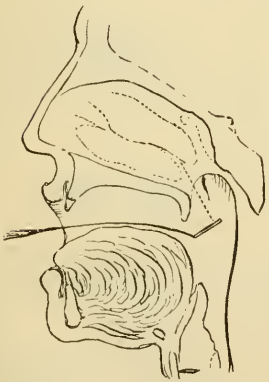


FIG. 437.[5]

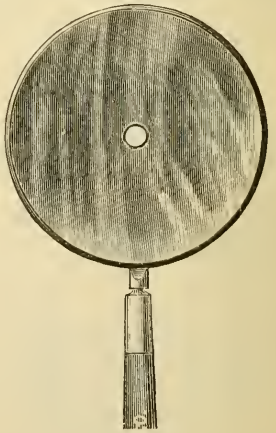


FIG. 438.[6]

seated in front of a good light, the mouth opened widely, the tongue behind the lower incisors, where it may be depressed by the spatula, pass the mirror into the pharynx, over the median line of the

[1] Davis & Collins. [2] L. Elsberg. [3] Thudichum. [4] F. Simrock.
[5] T. R. Brown. [6] G. Tiemann & Co.

tongue, until it is in the free space between the base of the tongue, the laryngeal opening, the posterior wall of the pharynx, and the velum; it should stand on the right or left side, to avoid the uvula, with its upper edge brought close to the posterior wall of the pharynx; the problem is to introduce the mirror and not touch the patient[1] (Fig. 437).

A reflecting mirror adds much to the illumination of the parts (Fig. 438); the hand mirror being introduced, the light is reflected from the external mirror upon the internal.[2] The soft palate often seriously obstructs the inspection by falling backwards against the pharyngeal wall; this can only be overcome in many patients by a hook,[3] or the elevator of the mirror (Fig. 436). The parts to be seen are the vault of the pharynx, the septum in the median line, the posterior portion of the middle turbinated bone, and part of the middle meatus; part only of the superior and inferior turbinated bones are seen; the posterior surface of the velum is exposed, and laterally the orifices of the Eustachian tubes.[3] Palpation is absolutely necessary to render conclusions certain; the patient sitting, pass the forefinger, during inspiration, behind the velum, and turn the point upwards as far as the posterior nares; the points examined are, the posterior surface of the velum, the septum, and the pharyngeal orifices of the Eustachian tubes; to avoid retching, the examination must not be prolonged; points that cannot be reached by the finger may be palpated with the laryngeal sound.[1]

2. **Medication** of the fossæ and parts posterior may be effected by the spray and the douche. It is alleged that inflammation of the ear may be caused by the penetration of liquids to the cavity of the middle ear through the Eustachian tubes: to prevent the occurrence of this accident, direct the patient to abstain from efforts at swallowing, by drawing out the tongue, and to breathe calmly with widely opened mouth.[3] The spray (Fig. 439), medicated, may be thrown into

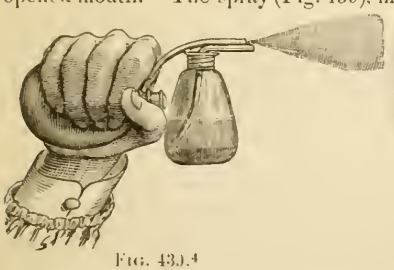


Fig. 439.[4]

Fig. 440.[4]

all divisions of the fossæ through the anterior meatus; its application to the posterior nares and parts adjacent is effected by an atomizer having an upward cast, introduced behind the soft palate (Fig. 440). When the douche is used, the liquid enters one nostril, the velum is elevated and closely approximated to the posterior pharyngeal wall

[1] B. Fraenkel. [2] A. E. Durham. [3] L. Elsberg.
[4] Codman & Shurtleff.

so that the nasal cavity is closed posteriorly in such manner that the fluid running through the posterior nares escapes by the opposite nostril and is received into a vessel; the entire nose and upper part of the pharynx is thus thoroughly bathed.[1]

The little vial of this apparatus (Fig. 439 and Fig. 440), is connected with the tube by means of a metal cap, having a coarse screw thread within it corresponding to a similar thread cast upon the neck of the vial, so that the atomizer may be held and operated with one hand without danger that the vial will be detached; when the vial is turned into the cap so as nearly to exclude air, the spray is rendered exceedingly fine; the tubes are of such length as to permit the atomized fluid to be applied directly to the laryngeal and pharyngeal regions. The nasal douche consists of A, reservoir, to contain one quart; B, leading tube, three feet long; C, nozzle, fitting the nostril in such a manner that liquid cannot pass outward, nor air into the nostril; D, joint formed by inserting a short glass tube within the rubber tubing, at which nozzles of different sizes, or for different patients, may be connected without loss of time.

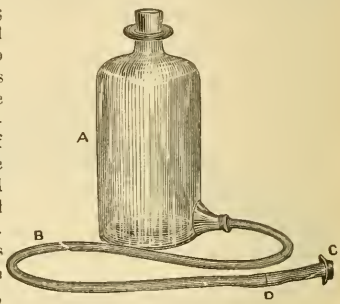


FIG. 441.[2]

A convenient douche (Fig. 442) may be used with the water-pitcher. To start the current, put the weight and about half the rubber tube with it into the liquid; the reservoir is placed higher than the head, and the rubber tube is grasped near the nozzle, between the thumb and finger, so as to control the current; the nozzle is then depressed enough to allow a little of the liquid to escape, thereby expelling air from the tube; it is then pressed gently into the nostril, and the grasp slightly relaxed, when the current will enter and fill the whole cavity of the nose, and escape by the opposite nostril; the head at this time being thrown slightly forward over a basin, and the mouth kept open. The fountain syringe is a still more convenient douche.[4]

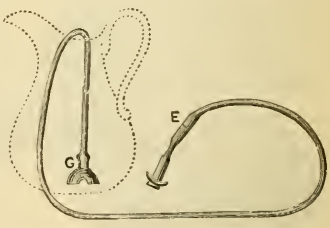


FIG. 442.[3]

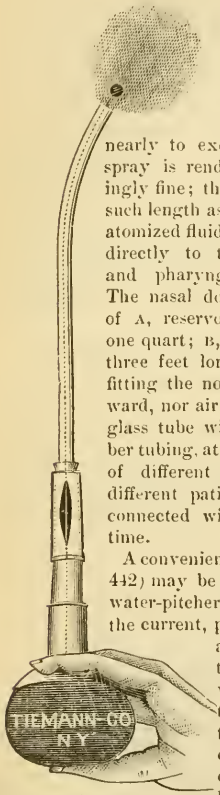


FIG. 443.

Insufflation of powders may be made anteriorly or posteriorly;

[1] B. Fraenkel. [2] Thudichum. [3] Codman & Shurtleff. [4] L. Elsberg.

the former requires a tube having a chamber for the powder; the powder may be blown out, or an India-rubber ball, by which the powder is driven out and diffused, may be attached (Fig. 443); but any tube, or even a quill, with a bit of India-rubber tube attached, may be used for the purpose;[1] the latter may be effected by glass, hard rubber (Fig. 444); or metal tubes, curved at the extremity, intro-

Fig. 444.[2]

duced behind the soft palate. Fluids may be applied with a brush or sponge, the brush and sponge-holder should be of sufficient length and appropriate curvature for making the applications either into the nostrils or through the mouth.[3]

A syringe, with a suitably curved nozzle, adapted to injections into the posterior nares, has the advantage of the application of fluids directly to the diseased parts, without the danger of their entrance into the middle ear through the Eustachian tube. If the nozzle has several perforations, the fluids may be distributed over a large area as a coarse spray.

3. **Imperforate nose** may be congenital, when it is caused by a membrane stretched across the nostrils, or by firm fibrous tissue, or by simple continuity of the integument. In congenital closure the interference with respiration and sucking often requires an early operation; in most cases a simple incision carefully made through the obstructing membrane, and the opening maintained by strips of lint, or a short elastic canula, is sufficient; sometimes it may be desirable to excise a portion of the obstructing tissue; when there is no indication of the opening of the nostril, the adherent parts must be gradually and cautiously divided until the nasal canal is restored.

4. **Occlusion** occurs at different points. Closure of the nostrils may be by membrane or fibrous tissue, or result from catarrhal inflammation;[3] or one ala, or both, may be adherent to the septum, or even to the upper lip; as these defects interfere with respiration and prevent the infant from sucking freely, they demand early operation; make a simple incision of sufficient extent carefully through the membrane, or excise a portion and keep it open by lint or canula until the cut surfaces are healed. Bending of the cartilaginous or bony septum causes more or less complete closure on the convex side. If the cartilaginous septum alone is affected, excise a portion on the convex side by slicing with a narrow probe-pointed bistoury, care being taken to avoid perforating it.[4]

[1] H. Knapp. [2] Tiemann & Co. [3] L. Elsberg. [4] S. D. Gross.

The bony septum may be fractured and made straight as follows:[1] Introduce a pair of smooth, thin-bladed forceps, grasp the septum and close the blades; the septum is fractured and the fragments are brought into a straight position; a metal clamp with thin blades is now introduced and tightened; this apparatus is retained as a splint until the bones unite, which usually occurs in two weeks; the clamp must not be too tight (Fig. 445).

Fig. 445.

Narrowing, or stenosis, of the deeper passages may be sufficiently overcome in infants by the use of hollow bougies as dilators, or, in more severe cases, by forcible distention by means of a pair of thin, long-armed forceps, by the opening of which the abnormally approximated bones are separated.[2] Bony closure of the posterior nares may exist from a continuation of the free posterior border of the palate bones upward and backward; this occlusion may be overcome by perforation of the bony plate.[3]

5. **Hæmorrhage**, epistaxis, is of very common occurrence, owing to the immense distribution of blood-vessels throughout the cavities, and the existence of cavernous bodies between the periosteum and mucous membrane on the turbinated bones; bleeding may be spontaneous, or result from injury, and when severe there is a rupture of vessels; the diagnosis is easy when the hæmorrhage continues, but if it have ceased, an examination of the nasal passages, and the history of the attack, determines its origin.[3] In the treatment, discrimination and judgment are as frequently required as skill, for it is as important to decide wisely as to the necessity of arrest, as to devise and apply the best means of effecting it; in many cases, the conditions which have given rise to the bleeding require treatment, rather than the incidental and temporary flow of blood; the non-recurrence of periodical or habitual epistaxis may betoken the approach of danger; in others, the sudden arrest of the bleeding by surgical interference may be followed by symptoms of the gravest import.[4] In general, the hæmorrhage should be arrested when it seems to be dangerous, or when, by its severity or the frequency of its recurrence, it begins to produce symptoms of acute or chronic anæmia. The end sought in treatment is the formation of a coagulum. The simple measures should first be employed; place the patient in the sitting posture, the head inclined slightly forward, remove all articles from the neck which prevent the free flow of blood; secure the most perfect possible state of rest of mind and body, and encourage quiet respiration without speaking, or blowing the nose.[3] The simple means are cold to the nose and forehead, or to the back of the neck,

[1] W. Adams. [2] Hoppé; B. Fraenkel. [3] B. Fraenkel. [4] A. E. Durham.

elevation of the arms above the head, astringent injections as of alum, tannin, zinci sulph., astringent spray, mustard foot-baths. As in a large number of cases, the bleeding spot is near the anterior and lower border of the septum,[1] the bleeding may often be arrested by pressing the ala of the affected side against the septum in such a manner as to close the nostril, and the front and upper part of the nose; or the finger may be applied directly in the nostril; or a compress of lint, tied with a string with which to remove it, may be introduced into the nostril;[2] wicks or strips of linen may be introduced through the nose to the pharynx,[3] and they may be sprinkled with tannin,[4] or dipped in persulphate of iron,[5] to increase their styptic qualities. If these measures fail, either compression must be made by the rhineurynter, or the posterior nares must be plugged; the former is a simple inflative balloon which is introduced into the nostril while empty, and then inflated by means of a flexible tube, and maintained full by closure of a stop-cock. The posterior nares are plugged by means of the catheter tube (Fig. 446).[7] Introduce the tube, with spring withdrawn, along the floor of the nose, 6 (Fig. 447), until the pharynx is reached; advance the spring, which, after passing around the velum, appears in the mouth; attach a thread to the tampon through the small eye in the button at the end of the spring, and withdraw it; the tampon, 8 (Fig 447), passes backward behind the soft palate; as the tube is withdrawn the plug is lodged in the posterior nares; the threads of the tampon must be brought out, one from the mouth and the other from the nose, and knotted; when the tampon is removed, untie the threads and draw it backwards through the mouth.

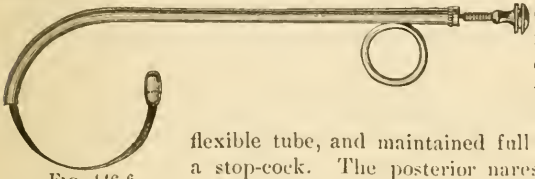


Fig. 446.[6]

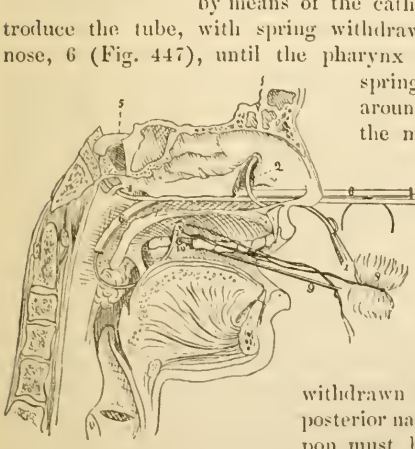


Fig. 447.

[1] A. E. Durham. [2] B. Fraenkel. [3] Thompson. [4] Curtin. [5] L. Elsberg. [6] G. Tiemann & Co. [7] Belloc.

6. **Foreign bodies** may be introduced, or may form in the nasal cavities; the former embrace all substances which may be forced through the anterior or posterior meatus, and the latter is confined to concretions, calculi, which form around some nucleus. The symptoms vary; these substances may remain long in the nasal cavities without causing any trouble; but, in general, their immediate effect is circumscribed inflammation, with purulent, bloody, and often fetid, secretions. The diagnosis is made out from the history and exploration; if the history is doubtful, inspect the cavities, remembering that the foreign body may be covered with secretions; finally, explore with the probe, distinguishing by the sensation, sound, and mobility, between the movable body and the bone.[1] Early removal must follow detection of the body. Sneezing and the douche are sometimes effective; the most convenient instruments are thin, short, straight, dressing forceps, and small scoops; care is requisite in seizing the body lest it be pushed more deeply into the cavity.[2]

7. **Abscess** forms in the epidermoid lining of the nose, the result of inflammation, either spontaneous or traumatic; the course of this affection is usually rapid, and the abscess opens at the end of a few days, with relief; it may assume a phlegmonous character, attended with great swelling of the mucous membrane, œdematous swelling of the external parts of the nose and adjacent parts of the face and lower eyelids, severe pain and fever, and terminate in wide-spread suppuration; or the inflammation may even reach the meninges of the brain.[1] The treatment of the mild form should be cold, leeching, and early opening of the abscess. The phlegmonous variety requires active measures to promote local suppuration, as applications of warm vapor, cloths wrung out of hot water, poultices, free incisions where the skin is tense, and early opening of the abscess.[3] Acute abscess may form in the septum and give rise to severe pain and high fever; the inflammation may extend to the upper lip and to the frontal sinuses and lachrymal passages; the surface is red, shining, tender on pressure, has an extensive base. In the treatment prevent the formation of pus if possible; but failing, open the abscess by free incision as soon as it is formed, followed by soothing and astringent washes.[2] Chronic abscess commences often without assignable cause, and progresses insidiously; it may be mistaken for polypus or thickening of the mucous membrane; in a majority of cases it terminates in perforation of the septum; the abscess must be opened early, and perforation prevented by injections of detergent solutions, as arg. nit., zinci sulph., acid carbol.

8. **Papillomata**[4] consist of immature connective tissue having a

[1] B. Fraenkel. [2] A. E. Durham. [3] W. Parker. [4] M. Mackenzie.

papillary arrangement with imprisoned portions of muciparous glands; they are generally situated on the inner surface of the alæ, are met with more frequently in children, cause irritation, but do not attain sufficient size to cause much embarrassment of respiration or alteration of the voice; they should be removed with curved scissors, or twisted off with forceps.

9. **Mucous polypi**[1] are localized hypertrophies, or outgrowths of the mucous membrane and submucous tissue; in consistence they are soft, pulpy, and somewhat elastic; in color, pale, yellowish, grayish, or slightly greenish; in appearance, shining and semi-transparent; they are, as a rule, pedunculated and pendulous, and more or less movable, single or multiple, pear-shaped, or irregularly lobulated to fit the cavities in which they lie.

They rarely, if ever, spring from the mucous membrane covering the septum; are most frequently connected with that which covers the superior and middle turbinated bones, and lines the superior and middle meatus, but may arise in the lower meatus, or be attached to the inferior turbinated bone, or the roof of the nose, the ethmoidal cells, or even the frontal sinuses; in the nostril they tend to fill the cavity and protrude forwards or backwards, sometimes expanding the alæ and even the nasal processes of the superior maxilla, or hanging down behind the uvula into the pharynx.

The symptoms are fullness and weight about the affected nostril, which gradually become so much obstructed as to interfere with respiration and the voice, especially during damp weather, when the growths become fuller and paler in color; the diagnosis is generally easily made with the nasal speculum and rhinoscope. The treatment is removal. Evulsion is the most simple, certain, and rapid method of removal, and may be performed with forceps or the snare.[1] The forceps should be strong, short, with blades slightly bent laterally, grooved longitudinally, and well serrated along their edges (Fig. 448); if the polypus is situated posteriorly, and must be removed through the mouth, the forceps must have the proper curve (Fig. 449).[2]

Fig. 448.[3]

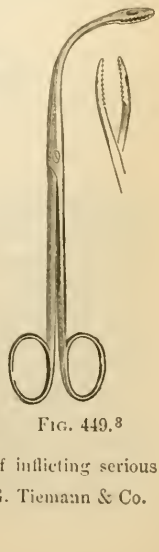


Fig. 449.[3]

Anæsthetics are often required, especially in delicate women, but there are marked advantages when the patient is able to submit without this agent, such as clearing the nasal passages, and preventing the entrance of blood into the air-passages.[1] Great care must be exercised in applying the forceps and removing the growths to avoid the risk of inflicting serious

[1] M. Mackenzie. [2] A. E. Durham. [3] G. Tiemann & Co.

damage by tearing away unnecessarily the mucous membrane or the turbinated bones.[1]

Place the patient in a chair, in front of a good light, with the head thrown back and supported by an assistant, who also elevates the tip of the nose, as the external opening of the nostril is on a lower level than the floor of the nasal cavity; introduce the blades of the forceps closed into the nose; glide them along the floor or septum until their extremities have reached and passed to some extent the visible portion of the polypus; open the blades in a vertical or oblique direction, turned upwards and outwards so as to include as much as possible of the growth; seize it firmly, and tear it from its attachments by traction and rotation of the forceps on their long axis; if the polypus yields without being detached, grasp it close to its roots with a second forceps, and twist it off at its origin.[1] When the growth is situated far back, pass the forefinger of the left hand round the soft palate into the posterior nares, and guide the forceps, introduced from the front, to the peduncle; if the polypus is very large, and attached at several points, extract it in successive portions.[2] If the polypus is situated posteriorly and hangs down into the pharynx, it may be seized by properly-curved forceps passed through the mouth, and behind the soft palate,[1] or it may be detached by forceps introduced through the nostril and pushed backward into the pharynx.[3] The thermo-cautery may be used, when the growth is easily accessible, for the destruction of the base.

The snare best adapted for evulsion (Fig. 450)[4] consists of the nasal portion, the ring, the cross-piece, and a quadrangular stem; there is a hinge which gives any angle to the shaft; in

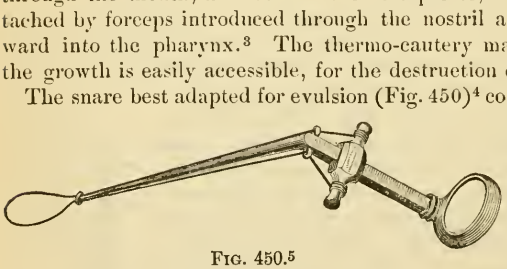


Fig. 450.[5]

preparing it, pass a wire through the doubly-perforated extremity, and through two small holes, and attach it on either side with the sliding cross-piece, making a loop beyond the bulbous end; in using it, advance the cross-piece as far as possible, which projects the loop; introduce this loop into the nostrils with the end of the shaft, and pass it over the polypus to its pedicle; draw the cross-piece down the shaft, fixing the loop firmly to the growth, then twist and pull until the growth is detached.[1] Polypi have been removed by the forefingers, one pressing through the nostril anteriorly, and the other posteriorly, until it is detached.[6] The galvano-écraseur may be used;[7]

[1] A. E. Durham. [2] M. Mackenzie. [3] J. Syme. [4] J. H. Hilton.
[5] Codman & Shurtleff. [6] S. D. Gross. [7] Thudichum.

the operation is attended with little pain, and there is no risk of hæmorrhage; but as the wire can rarely be adjusted to the pedicle, and no traction is made, the growth has to be removed in slices.[1] After the removal, the hæmorrhage usually ceases spontaneously, but may require the application of ice, or even the plugging of the nostrils; injections of astringents, or insufflation of tannic acid or other powders are useful in removing remaining portions of the growth.[2]

10. **The fibrous polypus**[1] springs from the periosteum, and is composed of bundles of compact connective tissue interspersed by elongated nuclei; some are of almost cartilaginous hardness, and the softer varieties are very vascular; it may grow from any part of the walls of the nasal fossa, but more frequently it is attached to the basilar process at the base of the skull, and first appears in the pharynx as a naso-pharyngeal polypus; it is usually distinctly pedunculated, but forms adhesions to opposing surfaces; in appearance, it is a red, fleshy-looking mass, hard, and resisting to the probe, tender, liable to bleed, frequently ulcerated, with a purulent and even fetid discharge; the growth at first causes the ordinary symptoms of mucous polypus, as nasal obstruction, epistaxis, mucous discharge; but as it spreads it causes absorption and displacement of the surrounding structures, pushes the septum to one side, penetrates the orbit, extrudes the eye-balls, forces the walls of the antrum outwards, causing the frog-face deformity, and even enters the cranium and compresses the brain; the treatment is thorough removal at the earliest stage practicable, and the result is generally favorable. Extirpation may sometimes be effected by the forceps, ligature, or galvano-caustic, at an early stage, when the growth has a small pedicle within easy reach. If the tumor is larger, it may suffice to cut through the alæ of the nose along their junction with the cheek, 1, 2 (Fig. 451), the nasal processes of the maxillæ and the skin with the mucous membrane covering them, and the septum; turn the nose upwards, remove the growths, and replace the parts;[2] or the nose may be divided above by a ∩ incision, 1, 2, 1 (Fig. 451), and turned downwards.[3] If still larger, excise the nasal bone thus:[4] make an incision from the junction of the frontal and nasal bones, 2, 3 (Fig. 451), vertically downwards along the mesial line of the nose to the upper margin of the alar cartilage, thence outwards to the cheek, 1 (Fig. 451) dissect off this triangular flap, avoiding the periosteum, and sever the alar cartilage from its attachments to the

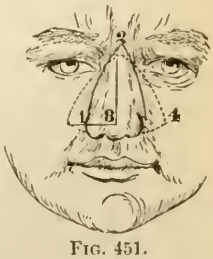


FIG. 451.

[1] M. Mackenzie. [2] A. E. Durham. [3] L. Ollier. [4] Von Langenbeck.

bone superiorly; separate the nasal bone from its fellow on the opposite side by bone nippers, and in the same manner cut away the nasal process of the superior maxillary from the body; with an elevator, raise the quadrilateral plate of bone upward so as to lay open the whole upper part of the nasal cavity; remove the tumor through the gap thus made, either by the knife or forceps; replace the parts disturbed accurately.

The larger tumors may also be removed through an incision of the hard palate[1] thus: divide the soft palate throughout its whole extent and thickness in the middle line; next make a longitudinal incision along the posterior half of the hard palate down to the bone, and two others obliquely outwards, one on each side, to the alveolar process; raise these flaps from the bone and reflect them outwards; perforate the palate and cut it away with forceps; divide the periosteum and mucous membrane of the floor of the nose and turn the flaps aside; excise as much of the vomer as may be necessary to expose the tumor, which may now be readily removed, unless of large size and too extensively attached; the opening in the palate should not be closed for some time after the operation, when staphyloraphy may be performed.

The largest growths require excision of the upper jaw;[2] extract the first incisor of the side affected; make an incision from the inner canthus, along the side of the nose and through the lip, in the median line, 1 (Fig. 452), a second incision 2, (Fig. 452), may be required from the malar bone to the angle of the mouth or ala; or 3 (Fig. 452), to the inner canthus; dissect up the flap thus formed and expose the bone; with forceps separate the bone in the median line from its fellow; divide the portion between the nostril and the inner margin of the orbit; saw through the malar tuberosity, and divide the soft palate in the median line; carefully free the bone from the superior maxillary nerve and other soft parts; separate the orbital plate, when it can be saved, with cutting forceps, and with lion forceps seize the mass and twist it out; remove the growth, apply the actual cautery to its attachments to arrest hæmorrhage and destroy the remnants of the tumor; carefully readjust the parts and retain them with sutures.

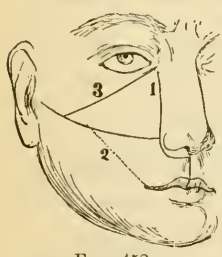


Fig. 452.

11. **Cartilaginous tumors** spring from the cartilaginous septum and the frontal and ethmoidal cells; as a rule they are hard, but may be quite soft; are never pedunculated and seldom ulcerate; when attached to the septum or fossæ, and accessible, they must be removed, as described.[3]

12. **Osseous tumors** may be exostoses, or ossified, cartilaginous, sarcomatous growths, or independent bony tumors; they are recog-

[1] E. Nélaton. [2] Flaubert; Tatum. [3] M. Mackenzie.

nized by their hardness; exostoses must be cut off, but the osseous tumor must be fully exposed by methods given, and extirpated.[1] The burr of the dental engine is a very effective instrument for removing the base of the tumor.[2]

13. **Sarcomata** are the representatives of the quasi-malignant growths; they are attached to the sides of the nasal cavities, are hard or soft; they may result from the degeneration of polypi, or spring up as sarcoma; they appear as fleshy, lobulated, succulent tumors, bright red, or of a dirty ashen hue, readily softening, ulcerating, bleeding, and attended by fetid discharges and severe pain; they must be removed, and generally by exsection of the upper jaw.[3]

14. **Cancer** originating in the nasal fossæ is rare, and should not be removed.[3]

III. THE ANTRUM.

The antrum,[4] maxillary sinus, is a large cavity in the body of the superior maxilla, lying above the molar teeth and below the orbital plate, lined in the fresh state by mucous membrane, and communicating with the middle meatus of the nose.[5] The relations of the antrum to the teeth vary extremely; it may extend so as to be in immediate relation to all of the teeth of the true maxilla, or may be so contracted as to correspond with only two or three of the central ones; occasionally a root or roots of the first molar extend into the cavity, free of any bony covering, and merely overlaid by the mucous membrane lining the sinus; the orifice which opens into the middle meatus varies from the size of a probe to that of the end of a little finger, 2 (Fig. 447).[6]

1. **Dropsy** may be due to the extension of nasal catarrh to the mucous membrane of the antrum,[7] or to the formation of cysts.[8] It appears as a gradual and generally painless expansion of the bone, and may encroach upon the nose, the orbit, or cavity of the mouth, causing obstruction and deformity.[9] For correct diagnosis perforations may be necessary. The treatment is evacuation of the contents by puncture at the most dependent part, or where bulging appears;[10] in some cases the front wall of the antrum must be cut away by raising the cheek at that point without dividing the lip,[11] the cavity cleansed and iodine applied to its walls, 3 (Fig. 452).

2. **Abscess**[6] results, in the majority of cases, from dental caries or alveolar abscess; there is a dull aching pain in the cheek, with heat, redness, and fullness of the soft parts externally; there may at first be purulent discharge from the nose, but the swelling of the mucous membrane soon closes the sinus; there is now throbbing

[1] A. E. Durham. [2] J. S. Cohen. [3] M. Mackenzie. [4] Highmore.
[5] Quain's Anat. [6] S. J. A. Salter. [7] B. Fraenkel. [8] M. Giraldès.
[9] T. Bryant. [10] S. D. Gross. [11] W. Fergusson.

pain, rigors, fever, expansion of the jaw, elevation of the malar bones, projection of the molar teeth, depression of the arch of the palate bone; the finger seldom fails to detect the fluctuation, but exploration may be made with a fine trocar and canula; the pus may escape into the nose, through the cheek, into an alveolar cavity, through the floor of the orbit; before the abscess has formed, and when as yet it is only imminent, remove any carious tooth or teeth in the neighborhood and apply leeches and fomentations; when pus has formed, extract all carious teeth from the maxilla involved, and if the pus is discharged from the cavity of either, enlarge the opening sufficiently to give free exit to the pus in the antrum; if there is no carious tooth, proceed as follows: Perforate the antrum by extracting the first permanent molar tooth, and passing a trocar into the cavity through its socket; the forefinger should be extended on the shaft of the trocar as a guard, and the instruments pressed forwards with an even, rotating motion; avoid the sudden giving away of the wall of the antrum and the plunge of the trocar through the wall of the orbit; if the teeth of the affected side have been long removed, the antrum is more readily perforated at the base of the malar process of the maxillary bone, over the region formerly occupied by the second or third molar tooth, by dividing the mucous membrane and employing a large trocar or a strong pair of scissors;[1] when the antrum is opened, wash it out thoroughly with warm water, followed by carbolic acid solutions; the entrance of food must be prevented by plugs of hard rubber, or by a plate fitted to the opening, with an opening which may be closed by a cork. It is sometimes practicable to open the passage from the cavity of the antrum to the nasal fossæ[2] with a probe properly directed, 3 (Fig. 447).

CHAPTER XLIV.

THE LARYNX.

The organ of the voice is situated at the top of the trachea, below the root of the tongue and the hyoid bone; it consists of a framework of cartilages connected by ligaments, and provided with appropriate muscles, blood-vessels, and nerves, and lined with mucous membrane; the cavity gradually narrows from its aperture downward to the space between the inferior edges of the orifices of the laryngeal ventricles; the narrowest portion of this space is the glottis, below which the cavity gradually widens and assumes the circular form.[3]

Its interior is divided into two cavities, an upper and a lower, which are separated by two horizontal lateral projections constituting the glottis, and which communicate by a cleft-like space between these projections, the rima glottidis.[4]

[1] B. C. Brodie. [2] S. J. A. Salter. [3] J. Leidy. [4] L. Elsberg.

Before using the laryngeal mirror, to prevent deposits of moisture, warm it over a flame, as the immersion in hot water, recommended by some, favors the decomposition of the silver coating of the glass.

1. **Examination** of the larynx is made with the mirror (Fig. 453). It may be made in the open air, before a window, or in front of a lamp or other artificial light, thus: Sit in front of the patient at such a distance as to obtain distinct and clear visions of the soft palate and wall of the pharynx; to explore the pharynx, direct the head to be slightly bent forwards (Fig. 454), so that the lower border of the upper incisor teeth shall be on a plane horizontal with the base of the soft palate, the mouth widely distended, the tongue thrust forwards towards the chin, and held by the patient with a napkin; take the stem of the mirror as in handling a pen, and during a deep inspiration, pass the mirror, warmed, well above the tongue, directly backwards, until it reaches the uvula; now flex the wrist and place the mirror with the lower border in front of the posterior wall of the pharynx; the uvula and soft palate are pushed backwards and somewhat upwards; the stem of the mirror is horizontal, and the reflecting surface looking obliquely downwards and backwards.[2] To explore the interior of the larynx, simply incline the head backwards (Fig. 455).

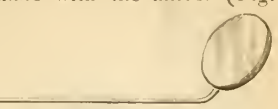


Fig. 453.[1]

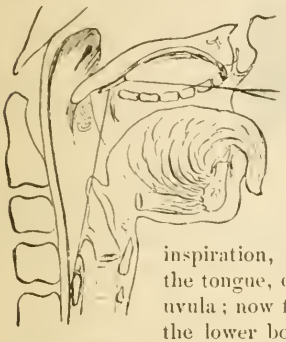


Fig. 454.

Fig. 455.

If artificial light is used with a reflector (Fig. 456), the lamp, the mouth of the patient, and the eyes of the observer, should be as nearly as possible in the same plane; the reflector should be arranged so as to throw the light into the open mouth of the patient and illuminate the middle of the soft palate, the uvula, and posterior pharyngeal wall; and then the mirror may be introduced.[3] The pharynx and larynx are brought into suitable position for examination when the patient pronounces *ai*, as in *fair*, for the larynx rises, the velum and uvula are lifted, and the tongue is depressed.[1] In this instrument the light is reflected from the mirror,

[1] Tiemann & Co. [2] J. S. Cohen. [3] A. E. Durham.

c, to the small mirror held at the posterior part of the mouth, the uvula resting upon its back.

The individual parts revealed by the laryngoscope, which are otherwise completely invisible or rarely or never seen without difficulty, are: the postero-inferior portion of the base of the tongue; the posterior wall of the pharynx down to its attachment to the cricoid and arytenoid cartilages; the upper cavity of the larynx with all its anatomical relations and contents; a portion of the lower cavity of the larynx, particularly its anterior wall; the anterior wall, and sometimes lateral walls of the trachea for a considerable distance, and under favorable circumstances, down to the bifurcation, and in a few instances, even throughout the whole length of the right bronchus.[2]

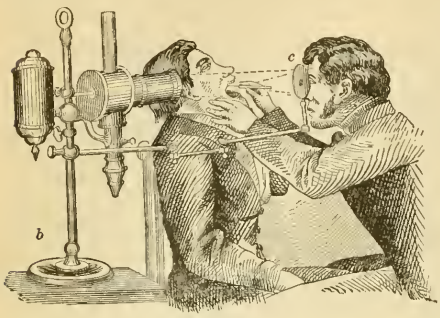


Fig. 456.

2. **Medication** may be with solid substances, powders, liquids, or vapors. The solids are most readily applied by means of a moderately thick aluminum or silver wire, mounted in a slender handle, and hollowed into a tiny cup (Fig. 457), or

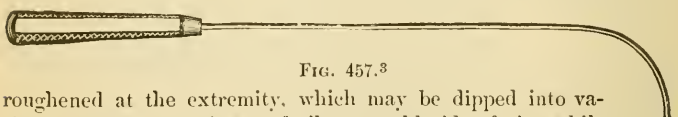


Fig. 457.[3]

roughened at the extremity, which may be dipped into various substances, as nitrate of silver, or chloride of zinc while in a state of fusion; the wire may be easily bent at any requisite angle, and there is no danger of any considerable portion breaking off. An ingenious concealed caustic holder (Fig. 458) may be used, which, by retraction of the tube, uncovers the caustic at the point of application. Powders may be applied with a brush (Fig. 459) or by means of the insufflator[2] (Fig. 460). Liquids may be applied by means of a sponge on a properly curved whalebone stem[4] (Fig. 462), or injected by means of the laryngeal syringe[5] (Fig. 463). In the form of vapor produced by the atomizer, medications of the larynx, together with the other passages, can be effectually made; the atomizer best adapted for general use is the following: —

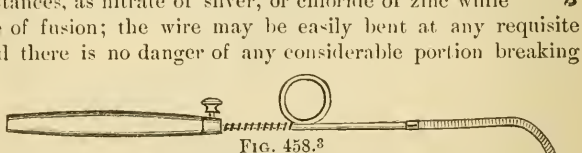


Fig. 458.[3]

[1] B. Fraenkel. [2] L. Elsberg. [3] G. Tiemann & Co. [4] Granger.
[5] A. E. Durham.

It consists of the sphere-shaped brass boiler A (Fig. 461), steam outlet tube B, with packing-box C, formed to receive rubber packing, through which the atomizing tube D passes, steam-tight, and by means of which tubes of various sizes may be tightly held against any force of steam by screwing down its cover while the packing is warm; the safety-valve E, capable of graduation for high or low pressure by the spring and screw in its top, the non-conducting handle F, by which the boiler may be lifted while hot, the medicament-cup and cup-holder G, the support H, base I I, the glass face-shield J, with oval mouth-piece connected by the elastic band K with the cradle L, whose slotted staff passes into a slot in the shield-stand M M, where it may be fixed at any height or angle required by the mill screw N. The shield-stand is formed into a handle just above the waste-cup O, and its base is formed to receive and hold this cup; it has also a sliding arrangement and set-screw, by which it may be fixed any desired distance from the atomizing tubes. The boiler is supplied with water through the funnel-shaped orifice into which the safety-valve is screwed.

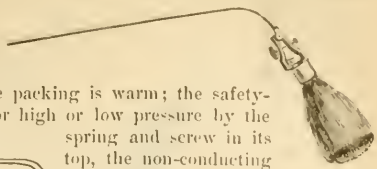


Fig. 459.[1]

Fig. 460.

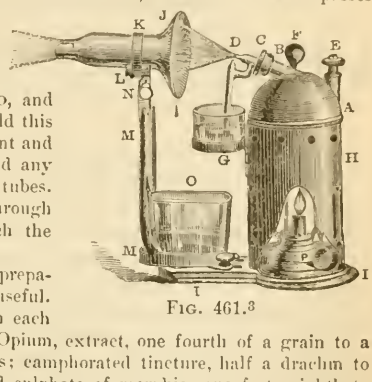


Fig. 461.[3]

The following formulæ[2] for the preparation of medicated solutions are useful. The amount of water is one ounce in each case, unless otherwise mentioned: Opium, extract, one fourth of a grain to a grain; tincture, two to twenty drops; camphorated tincture, half a drachm to four drachms; acetate, muriate, and sulphate of morphia, one forty-eighth to one eighth of a grain. Glycerin, a few drachms to an ounce, undiluted, or diluted with from one to ten parts of water. Table salt, one to twenty grains. Chlorate of potassium, one to fifteen grains. Permanganate of potassium, one half to five grains. Iron, tr. chloride, one to thirty minims; sulphate half a grain to ten grains. Alum, one to twenty-four grains. Sulphurous acid, ten to forty minims, undiluted, or diluted with from one to ten parts. Tannic acid, one to sixteen grains. Sulphate of zinc, half a grain to ten grains to the ounce of water. Sulphate of copper, one to twenty grains. Tr. iodine, one to twenty drops. Acetate of lead, one to ten grains. Oil of turpentine, one to five drops. Chloride of zinc, one tenth of a grain to two grains. Carbolic acid, one to two grains of the crystalized acid: carbolic acid water, five to ten drops. Infusion of tar, one to four drachms. Nitrate of silver, one sixth of a grain to ten grains. Corrosive chloride of mercury, one twelfth of a grain to two grains.

3. **Wounds** penetrating the larynx, such as are inflicted by suicides, though not usually attended by much hæmorrhage, are, as a rule, very dangerous, owing to the after complications liable to occur, as

[1] G. Tiemann & Co. [2] J. S. Cohen. [3] Codman & Shurtleff.

inflammation and œdema about the glottis, or in the trachea and bronchi, thickening of the mucous membrane around the wound, or the contraction of the cicatrices; punctured wounds, penetrating between the vocal cords, or injuring one or both, cause œdema about the glottis and suffocation; these wounds do not gape much, unless the cartilage is entirely divided, and hence the free escape of air, blood, mucus, and pus, is hindered, and there is a liability to emphysema, and the entrance of matters into the air-

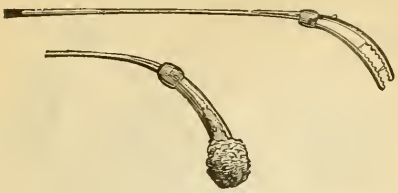


Fig. 462.[1]

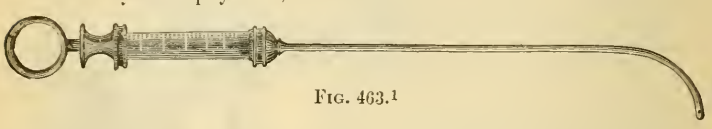


Fig. 463.[1]

passages. First, promptly arrest the hæmorrhage, if venous, by continued pressure; if arterial, by ligature or torsion of every bleeding artery; in emergencies it may be necessary to remove clots instantly from the mouth or pharynx, or suck blood from the trachea, or resort to artificial respiration; remove any portion of the epiglottis which may be loose, and if the tongue is divided and impedes respiration, prevent retraction by means of a ligature passed through its tip; when all bleeding is arrested, and there is no immediate hindrance to respiration, approximate the cut surfaces by placing the patient in bed, with the shoulders raised, the neck and head flexed, and the head fixed by bandages attached to each side of a firm night-cap and fastened to a roller applied around the chest; neither sutures nor adhesive plasters are required, unless the cartilages are cut in several places, and are much separated from each other, when one or more sutures may be passed through the cellular tissue surrounding them. The patient should remain in a moist and warm atmosphere, and the respiration be carefully watched; if it become obstructed, or emphysema appear, remove the sutures, if present, and search for the cause; if suffocation impends, enlarge the wound and introduce a tracheotomy canula, or make a fresh opening below and insert the canula; if constriction occur from cicatrization, tracheotomy may be required, after which dilatation may be effected with bougies; if fistulæ remain and respiration is not impeded by the closure of the fistulæ, pare the edges and unite them, or transplant skin.[2]

4. Fractures of the cartilages[2] are of extreme danger, owing to

[1] G. Tiemann & Co. [2] A. E. Durham.

the various obstructions to respiration to which they may give rise by the displacement of the fractured portions, the spasm of the glottis, the entrance of blood into the air-passage, the local or general emphysema, or by inflammation or œdema of the mucous membrane; there is usually flattening of the neck, ecchymosis and emphysema, when the mucous membrane is lacerated; the patient generally suffers great pain, aggravated by pressure and attempts at swallowing or speaking, with lividity, small pulse, convulsive cough, hoarseness, or aphonia; there is mobility of the fragments, and often crepitus is detected; but it must not be mistaken for the roughness elicited on moving the larynx of old people on the cervical spine.[1] The treatment of simple fracture, without dyspnœa, may be limited to external support of the parts with adhesive plaster; but when there is continued dyspnœa from the first, or bloody expectoration, or if suffocation becomes imminent at any period, perform tracheotomy without delay and adjust the displaced parts; retain them in position by suture, or an interlaryngeal splint consisting of an inflated rubber ring.[2]

5. **Foreign bodies** entering the larynx are arrested in its interior, or descend, according to their size, form, and weight; when arrested in the larynx, they may lodge in one of the ventricles or become fixed between the vocal chords; occasionally they are arrested at the junction of the larynx and trachea; the first symptoms of the entrance of the body into the air-passages are usually severe and characteristic; the patient gasps for breath, coughs violently, the face becomes livid, the eyes protrude, the body is contorted, and he is like one choked by the hand; if the body is lodged in the larynx, the symptoms will vary with its size and peculiarities; it may be so large as to prove fatal by suffocation, or so small, hard, and smooth as to cause but slight symptoms. Ordinarily there is aphonia, with pain and soreness, and uneasiness in that region ensues, with dyspnœa and whistling sound in respiration; at the same time there is absence of tracheal and bronchial disturbance.[3] The diagnosis is made positive when the symptoms permit an examination with the laryngoscope. In the treatment, as a general rule, the trachea should be opened with as little delay as possible in every case in which a foreign body is certainly known to be retained in any part of the air-passages, for by this means the immediate safety of the patient is secured, and subsequent expulsion or removal aided. An anæsthetic should always be given when the symptoms admit of delay, but in many cases there is not a moment to lose, and the trachea must be opened at once; even if the patient cease to breathe before this is accomplished, the operation should be completed, and arti-

[1] F. Le G. Clark. [2] L. Elsberg. [3] S. D. Gross.

ficial respiration instituted and perseveringly maintained. In those cases where the symptoms are so slight as to cause hesitation before adopting such severe treatment, delay is dangerous, for an interval of calm constantly precedes the recurrence of urgent symptoms, and temporary freedom from distress, instead of contra-indicating the operation, affords the best opportunity for its performance.[1] In deciding as to the particular form of operation in any case, it must be borne in mind that while laryngotomy is simple, easy, and free from risk, it is not as applicable to early childhood as tracheotomy, on account of the very limited dimensions of the crico-thyroid space. In the operation of laryngotomy, the structures to be divided are the skin, cervical fasciæ, and the crico-thyroid membrane (Fig. 464). Place the patient on a table with the head and shoulders properly elevated and firmly fixed (Fig. 465); make an incision with a narrow scalpel (Fig. 466) along the centre of the larynx, from the top of the thyroid to the base of the cricoid cartilage; this incision will be fully one and a half inches; if the crico-thyroid artery bleed, it must be twisted or tied; divide the crico-thyroid membrane in the same direction in its whole extent; if the opening is not sufficiently large, prolong the incision into the contiguous cartilages, or transversely.[2]

Fig. 464.

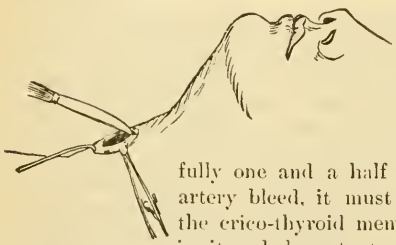


Fig. 465.

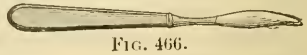


Fig. 466.

If expulsion should not immediately take place, introduce the double canula (Fig. 467), which secures freedom of respiration and stops hæmorrhage; the contracted muscles of the larynx may become relaxed, and the foreign body, set at liberty, be expelled. When the patient has recovered from the immediate effects of the operation, the canula may be removed, and the larynx explored by means of a probe; if the body is not detected, use a larger instrument, as an elastic catheter; the laryngoscope may also be used, and if the foreign body is detected it may be

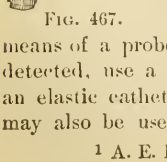


Fig. 467.

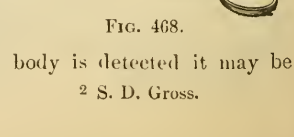


Fig. 468.

[1] A. E. Durham.

[2] S. D. Gross.

extracted with curved forceps (Fig. 468). If not extracted, the patient may now be safely inverted and the back struck repeated blows, which often dislodges smooth, rounded bodies, as shot, bullets, or pieces of money; if these means all fail, the larynx must be fully exposed.[1]

Thyrotomy, incision of the thyroid cartilage, is not a difficult operation, and does not involve much risk. Place the patient in the position already given (Fig. 465); make the incision through the cartilage perpendicularly upwards from the opening in the cricothyroid membrane previously made, and exactly in the middle line. Make the same search as before, and when the foreign body is removed bring the edges of the incision through the thyroid body together, and secure them by suture; the laryngeal tube may be retained a few days, until all indications of local mischief have passed away.[1]

6. **Œdema of the larynx** is a serous infiltration of the submucous connective tissue of the upper portions of the larynx; the most frequent seat is in the arytenoepiglottidean folds, but it may also involve the epiglottis, or involve the lips of the glottis, converting them into thick obstructing pads; it may occur in acute laryngitis, after the inhalation of hot vapors, or the deglutition of hot liquids, or suddenly, in the course of other diseases; but generally the immediate exciting cause is exposure to cold and moisture; the symptoms are marked, and in most cases come on more or less suddenly, and increase in severity with great rapidity; there is a sense of constriction in the throat, difficulty of inspiration, with a stridulous sound, feebleness or hoarseness of voice, dysphagia, and the phenomena of impending suffocation; inspection usually reveals inflammation and infiltration of the structures, but often no evidence of the disease is apparent; exploration with the finger detects the swollen tissues about the epiglottis; the laryngoscope reveals the exact location and extent of the effusion. The treatment is prompt incisions into the œdematous tissues. Scarification may be performed with a curved instrument (Fig. 469)[3] having cutting edges, or a ring (Fig. 470)[4] with a cutting point may be used on the end of the right index. If these instruments are not at hand, use a curved hernia knife, or a curved blunt-pointed bistoury, the blade being wrapped with cloth to within an inch of the point. Pass

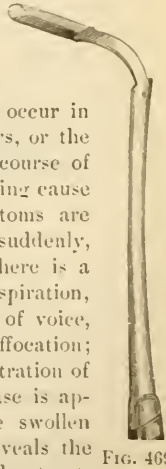


Fig. 469.[2]

Fig. 470.

[1] A. E. Durham. [2] G. Tiemann & Co. [3] G. Buck. [4] Grant.

the index finger of the left hand backward over the tongue to the epiglottis; along the finger as a guide, pass the knife, the edge forward, to the posterior part of the epiglottis, and incise the mucous membrane in several places. The tumid folds of membrane are readily felt by the index finger, which serves as a guide to the knife. It is a very simple operation, and gives instant relief to the most urgent symptoms; it should be performed even after respiration seems to have been suspended.[1]

7. **Burns and scalds**[2] result from inhalation of flames, hot vapors, and attempts to swallow boiling liquids; violent inflammation follows, with great pain in attempting to swallow, hoarseness, dyspnœa, and croupy symptoms, which gradually become extreme; in a fair proportion of cases little other treatment is required than a warm bed, the application of a hot sponge to the larynx, and the inhalation of warm, moist air; in more severe cases, blisters or leeches are useful; but if the symptoms rapidly progress and laryngeal spasm occurs, tracheotomy must be promptly performed, chloroform being given without fear.[3]

8. **Non-malignant growths**, polypi, in the larynx, may be papillomatous, fibrous, sarcomatous, adenomatous, cystic, cartilaginous, and osseous. The papillomata are far the most frequent; they appear as warty elevations from the mucous membrane, usually of the anterior part of the larynx, near the insertion of the true vocal chords, or from the boundaries of the ventricles, and in some cases from the true vocal chords; they are generally multiple, and sooner or later more or less completely coalesce. The fibrous growths usually spring from the true vocal chords or adjacent parts, are smooth and globular, may be sessile or pedunculated, and do not generally exceed the size of a pea. The adenomatous growth arises from the mucous membrane supplied with glands, as the arytenoid cartilages or folds, or the base of the epiglottis; when sessile, they appear lobulated; and when pedunculated, pyriform. Cystic tumors are rare, and may appear in almost any part of the larynx; cartilaginous and osseous growths have been recorded; mixed tumors may occur, in which the fibrous, fibro-cellular, and glandular elements vary in relative proportion. The condylomata of syphilis, the thickened elevations of phthisis, and the protuberances of localized chronic inflammation, can scarcely be distinguished in some cases from new growths. The symptoms are, in varying degrees of severity, difficulty of breathing, alteration or extinction of voice, and cough; but the diagnosis is most certainly made with the laryngoscope, or by digital exploration, especially in children. The treatment should be directed to the removal or destruction of

[1] L. Ravenhill. [2] A. E. Durham. [3] T. Bryant.

all non-malignant new growths as soon as practicable; in some cases it is absolutely necessary, and in others it may be desirable to perform tracheotomy before proceeding to any further operative measures. This question must be determined by the urgency of the symptoms, and the difficulties and dangers of the operation about to be undertaken. The methods of removal are estimated thus: (1.) Caustics are useful in small papillary growths; use the laryngoscope, and apply it with a properly curved caustic-holder. (2.) Forceps should be employed to remove small, fibrous, fibroid, fibro-cellular, and papillary growths; the forceps may be of various forms. (3.) The wire snare employed is applicable to cases in which the growths are soft and project so that they may be easily caught: the instrument should be properly curved and carry a wire loop.[1] (4.) The galvano-

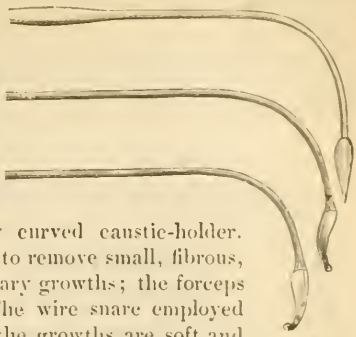
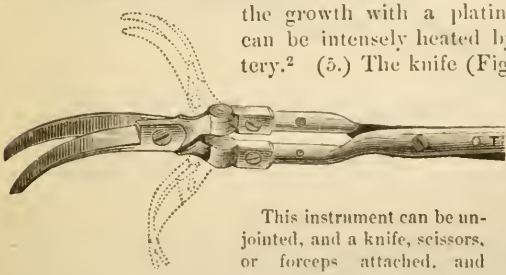


Fig. 471.

Fig. 472.

caustic is suited to single fibrous tumors with peduncles too strong to allow of their safe removal with forceps; it consists in encircling the growth with a platinum wire, which can be intensely heated by a galvanic battery.[2] (5.) The knife (Fig. 471)[3] and scissors (Figs. 472, 473)[4] may be used for the separation of firmly attached growths which cannot be pulled off by the forceps. (6.) Puncture is required, in the treatment of cysts, by a curved and guarded bistoury (Fig. 474).[7] (7.) Thyrotomy is the most certain and safest method



This instrument can be unjointed, and a knife, scissors, or forceps attached, and worked with the same lever.

Fig. 473.[6]

[1] G. Johnson. [2] Türck; Bruns. [3] Tobold. [4] H. Smith. [5] Bruns; Mathieu. [6] G. Tiemann & Co. [7] Buck; Mackenzie.

when the growths are numerous or very large, or single but firmly attached, and when the patient is young and ill able to bear the introduction of instruments through the narrow natural passages. The operation may be performed at once [1] where the growth is small, or, if large, when the removal could be effected by a slight amount of injury to intra-laryngeal structures; but if a great amount of injury is anticipated, it would be safer to facilitate respiration by performing tracheotomy in advance.[2]

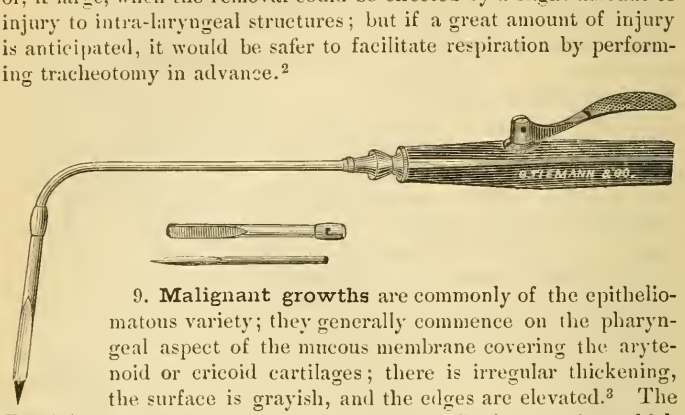


Fig. 474.

9. **Malignant growths** are commonly of the epitheliomatous variety; they generally commence on the pharyngeal aspect of the mucous membrane covering the arytenoid or cricoid cartilages; there is irregular thickening, the surface is grayish, and the edges are elevated.[3] The treatment is extirpation,[4] a not difficult operation, which gives 60 per cent. of recoveries.

The only special instrument required is the tampon-canula,[5] which consists of an ordinary tracheal canula, over the vertical part of which a ring-shaped rubber balloon is drawn; by means of a rubber tubing connected with it, provided with a stop-cock, this contrivance can be inflated with the effect of surround-

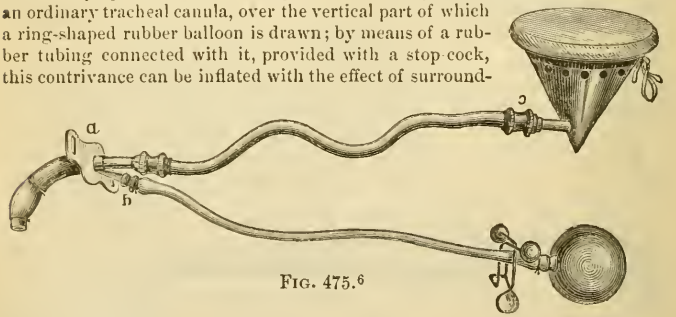


Fig. 475.[6]

ing the canula with a thick roll and obliterating the space between the canula and the trachea. Before the operation, tracheotomy is performed, the canula inserted into the trachea, and the rubber dilated, thus preventing the escape of blood into the lungs. The rest of the apparatus consists of a tracheal tube with a movable flange, *a*, an ether inhaler, *c*, covered with flannel, attached by a rubber tube to the tracheal portion at *a*; a bag connected at *b*, by a tube, with stop-

[1] E. Cutter. [2] J. S. Cohen. [3] A. E. Durham. [4] T. Billroth.
[5] F. Trendelenburg. [6] G. Tiemann & Co.

cock, to the rubber dilator, on the tracheal tube, for the purpose of expanding the rubber bag on the tracheal tube, and thus preventing the entrance of blood to the trachea. This instrument has recently been slightly modified [1] (Fig. 475) as follows: The tracheal tube is reduced in length, as also the rubber air dilator, at the extremity of the tube, which now forms a globular shape when inflated.

The steps of the operation [2] must be determined in each case by the nature of the disease; the simplest plan is as follows: a single vertical median incision from the hyoid bone to the second ring of the trachea, exposing the front of the larynx; the two sides of the cartilaginous box are then freed from the muscles quite back to the gullet; up to this point the larynx is not opened, and no blood can escape into it; the larynx is then separated from the trachea by a transverse cut, the trachea having been previously transfixed and held forwards with a sharp hook; a large syphon tube of vulcanite, fitting the trachea, is put in, to keep out the blood and permit free respiration; if this is neatly and carefully done, there is no need of preliminary tracheotomy and use of a tampon, which has the disadvantage of largely increasing the length of the wound. If there is much oozing of blood, something may be gained by lowering the head of the patient so that the flow of blood is in the direction away from the trachea; the upper and posterior attachments of the larynx are next cut, care being taken, in separating the gullet and pharynx, to keep the edge of the knife close to the cartilages, so as to avoid button-holing the gullet; it might be well to mop the raw surface out with solution of chloride of zinc, thirty grains to the ounce, at the close of the operation; but it is not advisable to irrigate the wound in any way afterwards, on account of the gulping and irritation which it sets up. Much may be done by keeping the air of the room pure and disinfected. The tracheal tubes should be as large as the trachea will admit, and those made of hard, polished vulcanite are best. When oiled inside and outside with carbolized oil, they are easily changed, and remain clean for a considerable time. The after-treatment requires careful attention to the tube, to avoid any disturbance of the respiration, protection of the lungs from cold or changes liable to cause pneumonia, a uniform temperature of 70° F. and carbolized air, and nourishing diet. Recovery has usually been rapid.

The last feature in the treatment is the introduction of an artificial vocal apparatus.[3] This must be delayed until the wound is fairly healed and contracted, before which time the apparatus is useless from its small size. This apparatus consists of two tubes, one of which passes into the open trachea, while the other, fitting into the tube, passes upwards to the epiglottis. Into the upper tube slides a silver case containing a plate with a vibrating reed. The anterior opening of

[1] G. A. Peters. [2] D. Foulis. [3] Gussnbauer.

the apparatus is closed by a button, and the current of air is directed past the reed, and through the aperture in the tubes. As the upward current impinges on the reed, the latter is thrown into vibrations, and a continuous musical note is produced, which is then modulated into vowels and consonants by the mouth. This instrument has been greatly improved in the power of vocalization by means of reeds made of better metals.[1] It is stated that the articulation of the patient with this apparatus is wonderful; except for the monotony, it cannot be distinguished from the natural voice; the vowels are perfectly clear and distinct, both in whispering with the reed out and in intoning with the reed in the tube.[2]

Extirpation of larynx, hyoid bone, portion of tongue, pharynx, and œsophagus, may be successfully performed as follows:[3]—

The patient being properly placed and under an anæsthetic, open the trachea and introduce the tampon-canula through which anæsthesia is maintained; make a transverse incision through the skin four fifths of an inch above the hyoid bone, from the inner edge of one sterno-mastoid muscle to the other; from the centre of this incision carry another in the middle line, over the larynx, close down to the tracheal opening; turn back the two flaps, expose the thyroid cartilage, and extirpate all infiltrated glands, whether lymphatic or submaxillary; divide the mylo-hyoid, digastric, and hyo-glossus muscles, and expose and tie the lingual arteries; now draw the larynx downwards and forwards by a sharp hook fixed in the hyoid bone, and draw the tongue out of the mouth by a ligature passed through the tip; divide the tongue at the proper place, tie the superior thyroid arteries, and cut through the lateral wall of the pharynx, and the pharyngo-palatine arches; expose the external carotid arteries, drawn forwards with the pharynx, tie them in two places, and divide between the ligatures; also, cut the lingual and hypoglossal nerves; the larynx now remains connected only with the trachea, which may be divided just below the cricoid cartilage; dress the wound by first inserting a tracheal canula, protecting the œsophagus, laying the flaps in apposition without sutures, and applying compresses wet with salicylic acid solutions.

A great variety of incisions may be practiced in making extensive dissections to remove growths in this region (Fig. 476). The root of the tongue may be engaged in the chain of the écraseur at 7, or the base may be exposed by the incision 3, 5, 4; or the base of the tongue, larynx, 5, 6, pharynx, and œsophagus may be exposed by dissecting flaps, 3, 5, 2, and 4, 5, 2, or the lip, chin, and inferior maxilla may be separated, 1, 5, 2, exposing the entire inside of the mouth. Though the removal of so many important parts requires an amount of dissection apparently destructive of conditions essential to life, yet experience has proved that recovery is often very prompt, and the sufferer has been made remarkably comfortable.

FIG. 476.

10. **Abscess** forms in the connective tissue, around and behind the larynx, and by its pressure causes difficult deglutition, dyspnœa, aggravated by horizontal posture, low and hoarse cough, quite different from the clanging, brassy cough of the early stage of croup; the treatment is evacuation of the pus as early as possible.[4]

[1] Foulds. [2] D. Foulis. [3] Von Langenbeck. [4] Stephenson; Parry.

11. **Bursal tumors**, hygromata, occur in the thyro-hyoid regions; (1) in front of the thyroid cartilage; (2) below the hyoid bone; (3) at the root of the tongue; they appear as cysts, and may increase in size so as to interfere with the deglutition, articulation, and respiration; treatment by puncture and injection of iodine, after discharge of the cysts, offers a better chance of success than incision, excision, or extirpation.[1]

CHAPTER XLV.

THE TRACHEA; THE THYROID BODY; THE BRONCHI.

I. THE TRACHEA.

The trachea (Fig. 477) extends from the lower border of the cricoid cartilage of the larynx, on a level with the fifth cervical vertebra, to a point opposite the third dorsal vertebra, where it bifurcates into the two bronchi; it is placed in the middle plane of the body and usually measures from four to four and a half inches in length, and from three quarters to an inch in breadth, though both the length and breadth vary according to the position of the larynx and the direction of the neck; in the neck and thorax it rests on the œsophagus. The common carotid arteries are situated on either side; the lateral lobes of the thyroid body embrace the upper end and its isthmus crosses just below the larynx.[2]

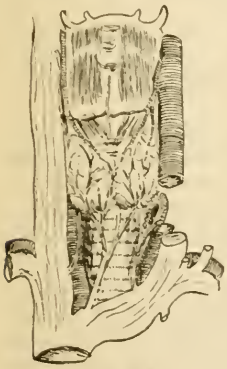


Fig. 477.

1. **Exploration** of the trachea is effected by the same methods as that of the larynx.

2. **Wounds**[3] which divide the trachea are usually attended by considerable hæmorrhage, as the superior and inferior thyroid arteries, the thyroid veins and the superficial jugulars are liable to injury; the thyroid body and recurrent laryngeal nerves are sometimes implicated. If the tube is partially divided, the edges of the wound gape but slightly and are easily kept in contact; but if it is completely divided, the ends separate widely, the lower being drawn downwards at each inspiration under the neighboring parts and thus impeding respiration. In deep wounds, the œsophagus rarely

[1] J. S. Cohen. [2] Quain's Anat. [3] A. E. Durham.

escapes, and, when injured, materials swallowed pass through the wound. The treatment is, prompt suppression of hæmorrhage by pressure of veins and ligation of arteries; approximation of the wound by flexion of the head on the chest, and, if the œsophagus is wounded, the passage of a tube by the mouth beyond the divided parts to convey food to the stomach; careful watching throughout to prevent suffocation from the entrance of blood or pus; and the prevention of constriction by granulations.

3. **Obstruction of the larynx and trachea** frequently occurs from the lodgment of foreign bodies, or inflammatory effusions within, as in croup, or pressure from without, as tumors. Foreign bodies are not often arrested in the trachea, but descend into the bronchial tubes; if arrested, they do not remain long, unless they are sharp and the end becomes implanted in its walls.[1] If the body is light, of small size, with no great irregularity of surface, it may constantly change its position, creating paroxysms of cough with lividity, swollen cheeks, and protruding eyes.[2] The diagnosis depends upon the history of the case, the sudden onset, and peculiarity of the symptoms. Whatever may be the cause of the obstruction, there is often a necessity for immediate relief to the embarrassed respiration; unless the cause is susceptible of prompt removal, the windpipe must be opened at some point. Laryngotomy should, as a rule, be preferred in the adult, and tracheotomy in young children.

4. **Tracheotomy** may be performed above, through, or below the thyroid isthmus; the latter place is to be preferred, as it gives more room for the canula. If there is immediate danger proceed as follows: the patient being anæsthetized or not, as may be deemed best, and firmly held, the shoulders elevated, and the head extended, stand at his right side and place the forefinger of the left hand on the left side of the trachea, and the thumb on the right side, and make uniform, steady, deep pressure until the pulsation of both carotid arteries is felt; now slightly approximate the finger and thumb until the trachea is firmly and securely held between them, and maintain this grasp until by repeated cuts in the median line the trachea is exposed; the forefinger of the right hand should be used from time to time to determine the relation of parts; when the trachea is exposed it may be opened at once, or seized by a sharp hook and held while it is opened; make the opening by thrusting the point of the knife (Fig. 465), the edge directed upwards, into the tube, and carrying it upwards to a sufficient extent.[2]

It is important to keep strictly in the median line, otherwise the canula will stand awry in the wound, and its extremity will be turned sharply against the membrane of the trachea, and will not only cause irritation, but will quickly

[1] S. D. Gross. [2] A. E. Durham.

become blocked with mucus.[1] The point of the knife must certainly penetrate the mucous membrane, which, if swollen, may be pushed before it; but it must not be thrust in too deeply lest it penetrate the posterior wall and the œsophagus; if the first opening is too small, it must be enlarged.[2]

If there is not immediate danger, proceed as follows: the patient being in position, carefully examine the region and determine the precise point of opening the tube; make a straight incision exactly in the median line, extending from just above the cricoid cartilage, nearly as low as the sternum; if the patient has a short, fat neck, make the first incision long enough; the subcutaneous fat and connective tissue being divided, the sterno-hyoid muscles are exposed, divided by a faint line, along which make an incision dividing the fascia; continue the dissection cautiously through the fascia and connective tissue, layer by layer, the separated tissues being held aside, and every bleeding vessel secured until the trachea is exposed and opened.

In every case, however apparently hopeless it may have become, the operation should be completed, and the tube introduced, even though the patient has ceased to breathe before this can be accomplished; the most persevering efforts should be made to effect resuscitation by aid of artificial respiration, and by sucking out the blood that may have entered the trachea, for recovery has repeatedly been effected in cases apparently the most hopeless.[2]

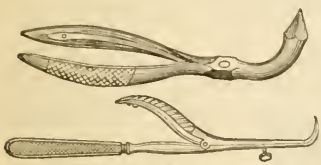


Fig. 478.

Various forms of tracheotomes have been contrived to render the operation more easy and less hazardous[3] (Fig. 478), but the use of all such instruments is of doubtful propriety: the surgeon who is competent to operate does not require anything of the kind, and in the hands of the incompetent they are likely to prove dangerous.[2]

The last stage of the operation varies with the object in view; if it has been undertaken on account of the presence of a foreign body, the edges of the opening should be held well apart by means of blunt hooks, or dressing forceps, or silk or wire ligatures may be passed through each edge of the wound, and tied behind the neck of the patient; if the body is comparatively large and impacted in the upper part of the trachea, it is better to introduce a canula into the tracheal wound, and

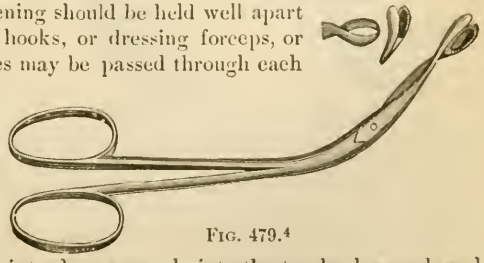


Fig. 479.[4]

[1] Sir J. Paget. [2] A. E. Durham. [3] Von Langenbeck; Rittna.
[4] G. Tiemann & Co.

wait until all spasm has had time to subside; if, however, the body is comparatively small and is situated in the lower part of the trachea, it is better to lose no time in attempting to extract it by means of forceps, lest it find its way into the bronchi.[1] The forceps best adapted to seize the body has a peculiar curve (Fig. 479), with broad beaks. Or, it may have a pliable shaft which can be bent at any curve, and will retain that position (Fig. 480); when introduced it may be closed, and then acts as a probe; if the foreign body is felt, the blades can be gently protruded, and when they inclose the body be closed upon it, and removal is readily effected. If the operation

Fig. 480.[2]

is undertaken for disease, a canula should be selected which can be worn with comfort, and which will be least liable to obstruction. It should always be double, and so curved as not to press upon the anterior wall of the trachea.

To avoid such results, the external canula should be so shaped as to pass directly backward (Fig. 481), and lie in the middle of the trachea; it must have a collar, through which the tube is moved by a screw, held in place by alar pro-

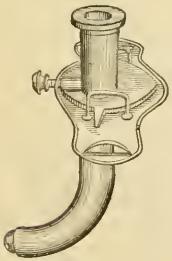


Fig. 481.

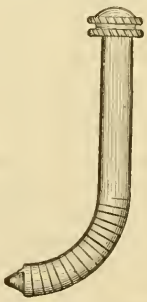


Fig. 482.

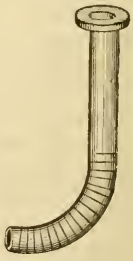


Fig. 483.

cesses, which pass under little wire arches; the inner tube has a jointed extremity (Fig. 483) which lies in the trachea, without creating any irritation.[1] To this instrument has been added an obdurator[3] (Fig. 482), which renders it the most perfect instrument yet constructed.

The hard rubber canula is very light and convenient, but does not offer any special advantages. The bivalve canula (Fig. 484) is convenient only in insertion; the two halves forming a wedge along

[1] A. E. Durham. [2] G. Tiemann & Co. [3] G. Johnson.

which the canula is afterwards passed. The canula may conceal a hollow trocar (Fig. 485) with which penetration is effected.

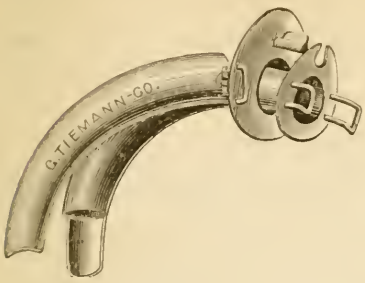


Fig. 484.

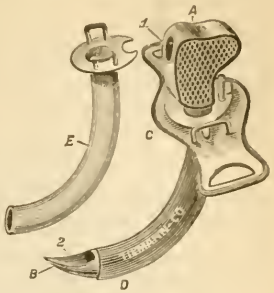


Fig. 485.

The introduction of the canula is often found to be difficult, and in the effort it may be thrust into the cellular tissue. Various instruments have been invented to aid in effecting it, as guides to the canula; as forceps (Fig. 486),[1] or a grooved spatula (Fig. 487),[2] or small grooved forceps (Fig. 488), or double hooks, worked by a spring (Fig. 489).[3] Practically, it will be found by far the best plan to use the canula mounted upon a blunt pilot trocar (Fig. 490): or an elastic catheter or bougie may be used as a substitute.

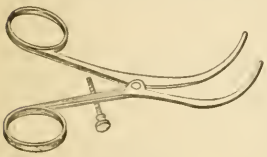


Fig. 486.

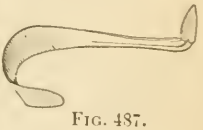


Fig. 487.

Fig. 488.

Fig. 489.

Fig. 490.

The after treatment[4] consists in closing the remaining wound with adhesive plaster; oiling the neck, if the case is diphtheria; maintaining a warm and moist atmosphere; withdrawing the inner tube of the canula, cleaning, and replacing it after it is well oiled; nourishing and sustaining the patient.

In most cases in which tracheotomy has been performed for croup, diphtheria, acute laryngitis, the constant attention of a vigilant and skillful nurse, during a longer or shorter period, is absolutely requisite; the superlative importance of careful watching, judicious management, and unwavering perseverance to the very end, cannot be exaggerated.

[1] Trousseau. [2] G. Buck. [3] Von Langenbeck. [4] A. E. Durham.

As the canula exposes the patient to the risk of bronchitis and broncho-pneumonia, it should be removed at the earliest possible period; to determine how necessary the instrument is, close the external opening from time to time, and watch the effects; it should not be withdrawn unless the patient can breathe for some hours with the orifice plugged. The wound usually closes rapidly, after the canula is removed.

II. THE THYROID BODY.

This body is situated in the lower part of the neck, and embraces the front and sides of the upper part of the trachea.

It consists of two lobes, united together towards their lower ends by a transverse portion, the isthmus; each lateral lobe is two inches in length, an inch and a quarter in breadth, and three quarters of an inch in thickness at its largest part; the direction of each lobe is from below obliquely upwards and backwards, reaching from the fifth or sixth ring of the trachea to the posterior border of the thyroid cartilage; the isthmus is nearly half an inch in breadth, and from a quarter to three quarters of an inch in depth, and lies across the third and fourth rings of the trachea.[1] In structure, it consists of a framework of connective tissue condensed externally to a more or less thick investing membrane, and traversing the interior of the organ as strong trabeculæ, and of gland vesicles, sustained by the framework, but completely closed and vesicular.[2]

1. **Wounds** of the thyroid are followed by hæmorrhage; ligate all bleeding arteries, and firmly approximate the edges with sutures and adhesive strips.

2. **Bronchocele, goitre,** begins as an hypertrophy of the gland substance or proliferation of the follicular cells; distinctions are based on the relative share taken in the hyperplastic process by other tissues, namely, if the stroma develops, the tumor has a soft consistency; if the connective tissue, it is hard and fibroid; if the arteries, it has a pulsating, aneurismal character; subsequent changes may be attended with the development of colloid matter in the follicles which leads to excessive enlargement, and by its softening causes cysts, or with amyloid and osseous metamorphoses, the former affecting the glandular parenchyma and vessels, and the latter the connective tissue and stroma.[3] The various kinds of bronchocele are, therefore, different stages of development, progressive or retrograde, of the simple hypertrophied gland.[4] The treatment depends upon the variety under observation: —

(1.) **Simple bronchocele** may vary in size, but generally retains the form of the thyroid body, if soft, and is rarely more than an inconvenience; it tends to change by increase of the fibrous stroma; the treatment is iodine, blisters, and iron.[4]

(2.) **Fibrous bronchocele** is smooth, hard, and unyielding, may be small

[1] Quain's Anat. [2] E. Verson. [3] E. Rindfleisch. [4] M. Mackenzie.

or large, and may involve any or all parts of the gland; the treatment is the passage of a seton through the whole substance of the gland transversely; twine or silk may be used, but twine is preferable, as it produces suppuration more quickly; from six to twelve threads are used.[1]

(3.) **Cystic bronchocele** is generally a blood-cyst and varies in size, being sometimes quite small, but may be so large as to hang down in front of the chest; it most frequently appears in the isthmus, but may occur in any portion; the form is globular, or ovoid, some cysts are movable, others are fixed; fluctuation may be distinct or imperceptible, depending upon the density of the walls; the treatment consists in conversion of the cyst into a chronic abscess, as follows: puncture the cyst as near as possible to the median line and at the most dependent portion; as soon as the trocar is felt to pierce the cyst wall, withdraw it and pass the canula deeper by means of a blunt-pointed key; when the fluid is withdrawn, inject a solution of perchloride of iron, ʒ ij to aqua ʒ j; insert a plug and secure the canula in position by a strip of adhesive plaster; repeat the injection at intervals of two or three days until suppuration is established, when the canula should be removed and poultices applied, as in a chronic abscess; in thirty-nine cases, thirty-eight were cured;[1] cases which have resisted all treatment and threaten life may be removed by incision.[2]

3. **Excision** is performed by observing the following steps of the operation:[3] place the patient on a firm table, with the head and shoulders elevated and supported, and give the anæsthetic; make an incision, vertically, of ample length, avoiding most sedulously any wounding of the tumor or its fascia propria; divide the successive layers of fascia upon a grooved director until the investment of the tumor is exposed; reflect the investment and enucleate the tumor as rapidly as possible with the fingers and handle of the scalpel, paying no attention to hæmorrhage, however profuse, but going as rapidly as possible to the base of the gland and compressing the thyroid arteries by seizing the pedicles with the fingers; transfixion of the pedicle from below upwards with a blunt, curved needle, armed with a double ligature, made of eight strands of saddler's silk, and tying each half, or, when practicable, dividing the pedicle into as many portions as there are main arterial trunks, and tying each portion separately; excision of the gland, firm ligature of all bleeding vessels, and subsequent dressing of the wounds, is as in ordinary cases.

III. THE BRONCHI.

The bronchi commence at the bifurcation of the trachea, opposite the third dorsal vertebræ, and diverge to the corresponding lungs; the right is wider but shorter than the left, about an inch in length, and passes almost horizontally into the root of the right lung on a level with the fourth dorsal vertebræ; the left is less in diameter, but longer, being nearly two inches in length, and inclines downwards and outwards beneath the arch of the aorta to the root of the

[1] M. Mackenzie. [2] W. W. Greene; T. Holmes. [3] W. W. Greene.

lung.[1] The septum, spur, or ridge which separates the bronchi at their origin is not in the median line, but decidedly to the left of it.[2]

Foreign bodies passing through the larynx and trachea generally enter the right bronchus, owing to the peculiar anatomical arrangement at the bifurcation; the symptoms[3] produced, and the obstruction to respiration, depend upon whether the substance is fixed or movable, its size, nature, and precise position; if impacted in one of the bronchi, the entrance of air into the corresponding lung is more or less impeded, or the obstruction may be complete with entire loss of respiratory murmur on the affected side; the body may not occupy the whole calibre of the bronchus, when the vesicular murmur will be diminished; or it may be lodged in one of the primary or secondary divisions, causing an entire absence of the murmur over a certain limited space; natural resonance on percussion is usually preserved; but as a rule the chest rises less, during inspiration, on the affected than on the sound side, and the respiration is puerile in the obstructed lung; fixed pain referred to the upper part of the chest when the body is immovable, or constant pain, with a sense of weight on one side, sometimes indicates the position of the foreign body; the voice may be hoarse, the respiration wheezing, the cough aggravated by deep inspiration; inflammation adds to these symptoms a copious and offensive expectoration, paroxysms of fever, night sweats, and exhaustion.[4] When the symptoms indicate that the foreign body is in one of the bronchi, tracheotomy should be performed, and the opening should be of considerable extent and as low down as possible.[4] The removal may sometimes be effected, if the foreign body is globular, by inversion of the patient and giving the posterior walls of the chest a blow, but care must be taken that the substance does not lodge in the larynx, and cause suffocation. If it is not dislodged it must be extracted by instruments; first explore with a long probe in order to learn the exact position of the body, then introduce suitably curved forceps and seize and remove it.

CHAPTER XLVI.

THE LUNGS.

These organs occupy by far the larger part of the cavity of the thorax, and, during life, are always in accurate contact with the internal surface of its wall.

Each lung is attached at a comparatively small part of its inner or median surface by its root; the pleuræ are two independent shut sacs which line the

[1] Quain's Anatomy. [2] S. D. Gross. [3] J. R. Leaming. [4] A. E. Durham.

right and left sides of the thoracic cavity; each pleura receives the apex of the corresponding lung, and projects, in the form of a cul-de-sac, through the superior aperture of the thorax into the neck.[1] They extend an inch, and, in some cases, even two inches and upwards, above the margin of the first rib.[2] The right pleura descends to the lower border of the ninth rib, and the left to the lower border of the tenth rib.[3]

1. **Injuries of the thoracic parietes** are important only as they affect the contained viscera. These wounds[4] may be simple contused wounds of the soft parietes, contused and lacerated wounds; or accompanied with injury to bones or cartilage; or complicated with lesion of some of the contents of the chest, the pleura remaining unopened, or, if opened, without a superficial wound. In the simpler wounds, in which the soft parietes only are involved, the healing process is often prolonged by the natural movements of the ribs to which the wounded structures are attached, especially when the ball has taken a circuitous course beneath the skin, and the surgeon must be on his guard to watch for pleuritis arising as an occasional consequence of these injuries.

When the force has been great, as when fragments of shell or rifle-balls strike at full speed against a man's breast-plate, not only may troublesome superficial abscesses and sinuses follow, but the lungs may have been compressed and ecchymosed at the time of the injury, and hæmoptysis be one of the symptoms presented. When the projectile has been of large size, although no opening of the parietes or fracture exists, death sometimes ensues by suffocation as the direct result of pulmonary engorgement. The danger of pleuritis or pneumonia will be greater when the injury has been so severe as to cause division of bone or cartilage, and the subsequent suppuration and process of exfoliation will not unfrequently prove very tedious and troublesome. Although the pleura has not been opened, the lung may be lacerated either by the force of contusion or by the edges of the fractured ribs, which may afterwards return to their normal relative positions, so as to leave no indication during life of the means by which the lung had been wounded. Such an injury would be rendered much more probable by the existence of old adhesions, connecting the pulmonary and costal pleuræ opposite to the site of injury. Notwithstanding a projectile has not penetrated the parietes of the chest, a pleural cavity may be opened, as in injuries from other causes, and the lung wounded by the sharp edges of fractured ribs. This will be indicated by emphysema, pneumothorax, hæmoptysis, probably signs of internal hæmorrhage, and inflammation. Such wounds will generally be the result of injuries from fragments of shell.

2. **Wounds of the pleura**[5] alone are very rare, but their existence has been demonstrated by actual inspection; they must be diagnosed by the absence of symptoms of wound of the lung; the immediate complications which may occur are lodgment of foreign bodies, hæmathorax, emphysema, pneumothorax; the secondary effects may be pleurisy, hydro-thorax, empyema, and fistula. In

[1] Quain's Anatomy. [2] C. E. Isaacs. [3] Luschka. [4] T. Longmore. [5] A. Poland.

the treatment, all manipulative examination is to be denounced as perfectly unwarrantable; beyond the removal of foreign bodies, the arrest of hæmorrhage, and the immediate closure of the external wound; rest and quiet, with low diet, must be enforced, and the symptoms watched to detect the occurrence of complications.

3. **Foreign bodies** lodged in the thoracic cavity may be successfully removed, but antiseptic measures should be persistently employed.

A slug of iron from a bursting gun entered the left chest just below the armpit, fracturing the sixth rib, and lodged beneath the heart upon the vertebral column, to the right of the descending aorta. Seventy-four days after, it was removed by the following operation, the patient being extremely prostrated: An incision three inches long was made in the track of the old wound, from the seventh over the sixth and fifth ribs; a transverse incision, three inches long, followed from the middle of the first; portions of the fifth, sixth, and seventh ribs were excised; the pleura was thickened, the lung collapsed, and large quantities of pus were evacuated during the search; the pulsations of the heart were strong against the exploring instrument, and the foreign body was at length detected under that organ, and was removed with forceps; a rapid recovery followed.[1]

4. **Paracentesis thoracis**, tapping the pleural cavity to withdraw fluid accumulated in it, is required:[2] (1) In pleurisy, at whatever date, where fluid is so copious as to fill one pleura, and begin to compress the lung of the other side, for in all such cases there is the possibility of sudden and fatal orthopnœa; (2) in double pleurisy, when the total fluid occupies a space equal to half the united dimensions of the two pleural cavities; (3) when the effusion being large, there has been one or more fits of orthopnœa; (4) when the contained fluid is purulent; (5) where a pleuritic effusion, occupying as much as half of one pleural cavity, has existed so long as one month and shows no signs of progressive absorption.

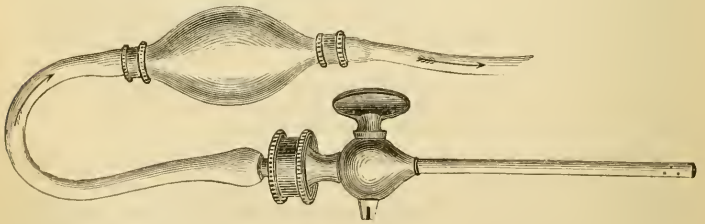


Fig. 491.[3]

The instrument consists of a trocar and canula[4] (Fig. 491), the latter being fitted to screw upon a flexible suction tube of the syringe;[5] the canula should be provided with a stop-cock; the trocar and canula being introduced within the

[1] E. S. Cooper. [2] F. E. Anstie. [3] Tiemann & Co. [4] A. Flint. [5] Davidson.

chest, the trocar is withdrawn and the canula attached to the syringe: the liquid is then removed by means of the expansion of the India-rubber suction bag after its compression with the hand. Any form of aspirator may be used, or the common trocar and canula; but in the latter case air must not be allowed to enter unless antiseptic spray is used.

The place of operation will vary within given limits, according to the amount of fluid collected. The indications are, to secure a sufficiently depending position and to avoid wounding the arteries and the diaphragm.[1] In general, the lower portion of the intercostal space must be selected as the intercostal arteries approach the centres of the spaces posterior to the angles, and anterior to the anterior third of the spaces; the upper limit should be the sixth rib, and the lower the eighth rib on the right: and the ninth rib on the left (Fig. 492). The point to be selected when there are no special indications is, the sixth intercostal space on the right, owing to the liver, and the seventh on the left, and midway between the spine and the sternum. Some[2] tap, by preference, below the angle of the scapula and between the seventh and eighth ribs, or the eighth and ninth ribs, at a point distant from two to three inches from the angles.

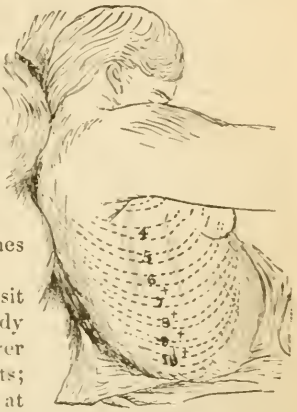


Fig. 492.

Operate as follows:[2] Let the patient sit across the bed so as to admit of the body being readily lowered and supported over the edge; carbolize all of the instruments; make a small puncture in the skin, just at the upper edge of the rib, with a narrow-bladed lancet or knife; puncture the cavity through this incision, giving the instrument a slight obliquity upwards, which will enable it to clear the edge of the rib; the depth to which the trocar or needle penetrates must depend on the thickness of the parietes, the presence of fat, muscle, or œdema, for which due allowance must be made.

Or, find the inferior limit of the sound lung behind, and tap two inches higher than this on the pleuritic side, at a point in a line let fall perpendicularly from the angle of the scapula; push in the intercostal space here with the point of the finger and plunge the trocar quickly in at the depressed part; be sure to puncture rapidly and to a sufficient depth, to prevent the occlusion of the canula by the false membrane.[3]

The amount of fluid withdrawn in any case must depend upon the condition of the patient and the lungs, care always being taken to avoid faintness.[4]

[1] A. Poland. [2] E. Cock. [3] H. I. Bowditch. [4] T. Watson.

When the flow ceases, instantly withdraw the canula, and place the point of the finger on the puncture until adhesive plaster is applied. If the common trocar and canula is used, the outward flow of fluid must not be allowed to intermit, lest air enter the cavity, unless the carbolic spray is in use.

5. **Concussion of the lung**[1] may result in serious functional derangement without organic lesion; it may be transient, and subside without ulterior results, or it may be succeeded by inflammation, either local or general, of the affected lung. There are no special diagnostic signs except, perhaps, the expectoration of blood-stained mucus without pneumonia after the lapse of forty-eight hours. The treatment should aim, (1) to relieve the shock, and (2) then the engorged lung by leeches over the part, and revulsives.

6. **Wounds of the lung**,[2] especially when the projectile lodges, are necessarily exceedingly dangerous. Fatal consequences are to be feared, either from hæmorrhage, leading to exhaustion or suffocation; from inflammation of the pulmonary structure or pleuræ; from irritative fever accompanying profuse discharges; or from fluid accumulations in one or both of the pleural sacs. When the chest has been opened by a projectile, the following signs may be expected in addition to the external physical evidences of the injury: namely a certain amount of constitutional shock; collapse from loss of blood; and, if the lung be wounded, effusion into the pleural cavity, hæmoptysis, dyspnœa, and an exsanguine appearance.

The shock of penetrating wounds of the chest, apart from the collapse consequent on hæmorrhage, is not generally so great as happens in extensive injuries to the extremities or in penetrating wounds of the abdomen. When loss of blood occurs without the lung being wounded, the hæmorrhage is probably proceeding from a wound of one of the intercostal arteries, which has been torn by the sharp ends of fractured bone. When blood is effused in any large quantity into the pleural sac — as indicated by the exsanguine appearance of the patient, increasing dyspnœa, occasional hœmoptysis, and the stethoscopic signs on auscultation — the inference is, that the lung has been opened, and that it is from its structure the blood is flowing. Hæmoptysis indicates injury to the lung, but does not give assurance that this organ has been penetrated. Dyspnœa is a frequent accompaniment of wounds penetrating the lung, but not a constant symptom before inflammatory action has set in. When dyspnœa is great in the early period, it will often be found to depend upon the injuries to the parietes, and on the pain caused on taking a full inspiration. If air and frothy mucus, with blood, escape by the wound, there can be no doubt of the nature of the injury. Emphysema is not common in penetrating gunshot wounds, but occasionally happens.

The treatment must in the first place be the arrest of hæmorrhage; afterwards the removal of pieces or jagged projections of bone, or any other sources of local irritation. Although the shock may happen to be considerable, attempts to rally the patient, if any be made,

[1] F. Le G. Clarke. [2] T. Longmore.

should be conducted very cautiously; the prolongation of the depressed condition may be valuable in enabling the injured structures to assume the necessary state for preventing hæmorrhage. Hæmorrhage from vessels belonging to the costal parietes should be arrested by ligature, as in other parts, if the source from which it proceeds can be ascertained, and if the flow of blood be so free as not to be controlled by ordinary styptics. Hæmorrhage from the lung itself must be treated on the general principles adopted in all such cases; the application of cold to the chest, perfect quiet, the administration of opium, and, if the patient be sufficiently strong, bleeding from a large opening until syncope supervenes. When blood has accumulated in any large quantity, and the patient is much oppressed, the wound should be enlarged, if necessary, so as, with the assistance of proper position, to facilitate its escape. If the effused blood, from the situation of the wound, cannot be thus evacuated, and the patient be in danger of suffocation, then the performance of paracentesis must be resorted to.

The extensive bleedings formerly recommended in all penetrating gunshot wounds of the chest are now practiced with much greater limitations — indeed, should never be employed simply with a view to prevent mischief from arising. Venesection carried to a great extent does harm by lessening the restorative powers of the frame. To remove splinters of bone, and readjust indented portions of the ribs, the finger should be introduced into the wound, care being taken that in doing so no pieces of cloth or fragments be separated and projected into the pleural sac. Notice must at the same time be taken of any bleeding vessel requiring to be secured. A pledget of lint should be laid over the wound, and a broad bandage placed round the chest, just tight enough to support the ribs and in some degree to restrain their movements, but with an opening over each wound large enough to permit the ready access of the surgeon to it if necessary. If the patient's comfort admits of it, he should be laid with the wound downwards, with a view to prevent accumulation of fluid in the pleura; and if there be two openings, as will be most frequently the case in rifle-ball wounds, one wound should be thus placed, and the upper one kept covered. In gunshot wounds, closure of the parietes by adhesion is of course not to be looked for. If the presence of a ball within the cavity be ascertained, efforts should be made for its removal; but any attempt to determine where the ball has lodged should be made very cautiously, as more harm may result from the interference than from the lodgment of the foreign body.

(1.) **Pneumocele**, hernia of the lung, sometimes occurs. If the protruded portion is uninjured, and healthy in appearance, it may be reduced by moderate manipulation, care being taken not to injure its delicate structure; if reduction is impossible, owing to constriction, and the protruded part is formed of soft structures, the neck may be cautiously divided, care being taken to avoid wounding the lung or intercostal vessels; if the lung is gangrenous, it may be left to slough or an elastic ligature may be applied.

(2.) **Emphysema**, the infiltration of air into the subcutaneous cellular tissue, may occur, recognized by the crepitating feeling under pressure. The treatment is pressure, if it is well borne; punctures and incisions are rarely required.

The air may be confined to the cavity of the pleura, pneumothorax. If the oppression of the breathing is very great, open the wound; or, if there is no wound, puncture with a trocar and canula.

(3.) **Hæmo-thorax**, hæmorrhage into the cavity of the pleura, may be so great that death ensues from the loss of blood and pressure on the lungs. The signs of severe hæmorrhage are, great oppression, restlessness, sitting up in bed the body bent forwards, countenance cold and pale; then follows syncope and utter prostration, the patient lying almost motionless, with occasional heaving of the chest. The most judicious treatment is, at first, to close the external wound, and allow the effused blood to coagulate, if possible, with a view to its ultimate absorption. But if the effusion increases, and causes the dangerous symptoms given, the external wound may be kept open or enlarged to allow the escape of the blood by position of the body; or the chest may be opened at a more dependent part; no attempt should be made to pump out the blood, or to soften the clot by injection of fluids.

7. **Puncture of cavities of the lung** has been frequently advised,[1] and many times performed with a view to evacuate the pus, and also to inject the cavities with medicated fluids. The results have not been such as to establish the value of the operation. The fluids injected have been five to ten minims of a dilute solution of permanganate of potassa;[2] or sol. carbolic acid and tr. iodine; or Lugol's sol. iodine.[3] The operation has been performed as follows:[4] The long duration of the affection was relied on to form adhesions between the two layers of the pleura at the point selected; an incision was then made through the skin and superficial intercostal muscles, commencing about two inches from the right border of the sternum and along the upper border of the third rib; the cavity was now opened with a suitable pair of forceps penetrating more and more deeply into the bottom of the wound; a drainage tube was introduced and fastened to the wall; Or a small trocar canula may be employed; Or a small aspirating needle may be used, with the vacuum formed, attached, especially in the first or exploratory operation.

8. **Circumscribed collections of pus**[5] frequently form in the pleural cavities of children, attended by cough and great emaciation; these cases are often mistaken for pulmonary phthisis, and prove fatal by penetrating the lung, or by exhaustion. The proper treatment is, early evacuation of the pus by aspiration, or incision. The abscess being carefully localized by percussion, make an incision and puncture over the upper margin of the rib; the track of the wound may be left open. The relief is usually immediate and recovery prompt.

[1] Barry; Massy; Hooken. [2] W. Mosler. [3] W. Pepper. [4] C. Hütér. [5] J. L. Smith.

IX.

THE URINARY ORGANS.

CHAPTER XLVII.

THE KIDNEYS.

These organs[1] lie at the back of the abdomen (Fig. 493), on the quadratus lumborum and psoas muscles, opposite the two lower dorsal and two upper lumbar vertebræ; the right is a trifle lower than the left, owing to the size of the liver; the pelvis of the kidney is about the level of the spine of the first lumbar vertebra; the upper border is about the level of the space between the eleventh and twelfth dorsal spines; the lower border is as low as the third lumbar spine.

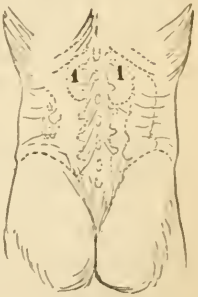


Fig. 493.

During a deep inspiration both kidneys are depressed by the diaphragm nearly half an inch; the healthy kidney cannot be felt by external examination, but the degree of enlargement and tenderness may be determined; care must be taken not to mistake for the kidney an enlarged liver, or spleen, or accumulation of fæces in the lumbar colon.

1. **Rupture of the kidney** is not necessarily fatal; its severity depends upon its location and extent, for it may involve the external covering, or be entirely internal. When the lesion is confined to the anterior surface, urine may escape, and cause acute and rapidly fatal peritonitis; if limited to the posterior surface, and urine escape into the sub-serous cellular tissue, suppurative inflammation is very liable to be established, with rigors, high fever, typhoid tongue, and œdema of the parts; if the rupture is internal, abscess may occur.[2] Blood may appear in the urine at once or after several days; if a small amount pass with the water, the rupture will not prove serious, for this symptom often follows bruises of the kidneys; but when the

[1] L. Holden. [2] J. Birkett.

hæmorrhage is copious and persistent, or recurrent, accompanied with pain, especially if followed by suppuration, the injury is serious.[1] The treatment should be rest; opium, to relieve pain, and quinine, in full doses, if the fever is marked.

A constant watch must be maintained of the lumbar and iliac regions to detect the appearance of swelling, in order to be prepared for the early evacuation of pus. A premature opening, in anticipation of the formation of matter, is preferable to delay in giving it vent when once established, for suppuration in the lumbar region spreads rapidly and produces intense constitutional disturbance.[1]

2. **Abscess of the kidney** may follow an injury, as rupture, or may result from interstitial nephritis or embolism; the kidney is markedly enlarged; its capsule and the adipose tissue in which it lies are congested and œdematous; beginning as a superficial affection, it no sooner extends to the renal parenchyma than it involves all the connective tissue of the kidney; and this, in turn, culminates in suppuration at various points; the pus may even make its way through a rent in the capsule and lead to the formation of dependent abscesses in the retro-peritoneal connective tissue.[2] The diagnosis[3] of traumatic nephritis rests upon the history of the injury, and the passage at first of blood and afterwards of pus in the urine, to which are added great local tenderness, chills with fever, dull or sharp pains through the part affected, and finally a tumor perceptible on examination.

When the abscess is idiopathic, and no adequate cause can be discovered, the diagnosis is exceedingly difficult, and frequently even impossible, not only in its early stages, but throughout its course; fever, occasional chills, gastric disturbances, vomiting, loss of appetite, and diarrhœa, are often the only objective symptoms; it is only when, in addition to those symptoms, there is tenderness over the region of the kidney, and a tumor can be made out which is evidently connected with that organ, or when rupture of the abscess occurs, that a diagnosis becomes possible.[3]

When the suppuration continues, in spite of well-directed efforts to control its progress, the question of the evacuation of the contents of the abscess, by incision, must be decided.

The following rules[4] defining the conditions under which nephrotomy is not proper, are perfectly good,[5] and should be duly considered: (1) When there is reason to suppose that both kidneys are diseased; (2) when the pus finds free exit by the bladder, no renal tumor exists, and the other kidney is performing its function satisfactorily; (3) when the bladder or prostate are incurably diseased, or grave lesions of other viscera exist.

3. **Perinephritic abscess** may result from injury, abscess of the kidney, or from unknown causes; it consists in the formation of pus in the connective tissue around the kidney. The symptoms are pain

[1] F. Le G. Clarke. [2] E. Rindfleisch. [3] W. Ebstein. [4] M. Rayer. [5] Van Buren and Keyes.

in the vicinity of the kidney, rapid pulse, fever, swelling in the lumbar and iliac region, which has a doughy feeling. As the disease progresses, the tumor enlarges, frequently filling up the iliac fossa and protruding under Poupart's ligament or along the edge of the ilium; it may also pass upwards behind the peritoneum, and, penetrating the diaphragm, form connections with the lung, and finally discharge through it, or it may find an outlet for its contents into the bowels, rectum, bladder, or vagina. The early treatment must aim to subdue the inflammation by absolute rest, laxatives, or enemata; leeching, opium to relieve pain, with quinine and nourishing food; auscultation of the lung should be frequently practiced, especially in obscure cases, to anticipate any tendency of the pus to find its way out in that direction.[1] Constant attention must be given to the formation of the characteristic enlargement in the lumbar region; when this appears and the nature of the disease becomes manifest, an early operation is demanded;[1] for a premature opening, in anticipation of the formation of matter, is better than that any delay should occur in giving exit to the pus.[2] The point of operation should be, as a rule, in the renal region (Fig. 493), to avoid the peritoneum, and where fluctuation is most distinct, unless the abscess point below, as along the ilium, or at Poupart's ligament; if the swelling is defined, and the abscess shows no sign of pointing, select the margin of the quadratus lumborum, or a point midway between the last rib and ilium, on a line vertical to the centre of the ilium, 1 (Fig. 494); introduce an aspirating needle, and if pus is found, make this the guide to a straight, narrow-bladed knife, and open the swelling freely; if pus is not found, carefully dissect the parts by transverse incisions through the skin, fasciæ, and connective tissue, until the abscess is reached, when it should be opened; if no pus is found, the wound should still be kept open for the purpose of securing the early escape of the first-formed pus. The outflow of pus once secured, must be maintained by tents, if necessary, and carbolized solutions must be freely injected to preserve the abscess from the irritation of retained septic fluids.

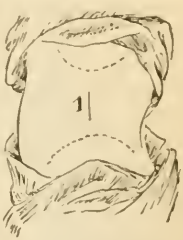


FIG. 494.

4. **Calculus in the kidney**[3] is a concretion caused by the deposit of the salts of the urine in the pelvis of that organ.

Renal stones are sometimes found singly, and again in considerable numbers; they vary much in number and size, being generally small, but they may be so large as to adapt themselves to the renal pelvis and calyces, and branch like coral, the number varying according as they include a larger or smaller num-

[1] H. I. Bowditch. [2] J. Birkett. [3] W. Ebstein.

ber of calyces. The greater number of stones pass through the ureter into the bladder, and this is the most common termination of nephrolithiasis; but sometimes a stone becomes so large that it cannot pass the ureter; it then continues to grow, at first filling the renal pelvis partly, afterwards entirely, and sometimes the calyces; the urine secreted above the stone is dammed up in proportion to the amount of hindrance offered to its escape, exercising considerable pressure on the renal tissue, which leads to atrophy of the parenchyma, and sometimes to complete disappearance of the organ, its place being filled by a membranous sac. The presence of renal sand is only learned by proper tests of the urine.

The symptoms caused by larger concretions, though sometimes absent, are usually distinct and often very characteristic. In general, there is pain, sometimes cutting or piercing, in the loins, or attended by a continual sense of pressure or tension. There may be violent paroxysms, renal colic, excited by jarring motions; the pain extends along the ureter and spreads over the abdomen, or radiates to other parts of the body, as the testicle, thigh, breast, shoulder; every movement is torture and the patient bends double, or lies on the affected side with the knees drawn up; vomiting occurs, and severe strangury, the urine being scanty, red, brown, or blackish, or loaded with blood, mingled with pus and mucus. The diagnosis rests upon those symptoms pointing directly to the kidney involved, and the behavior of the urinary secretion during an attack. The treatment should be directed (1) to prevent the formation of renal sand and gravel, and (2) to remove the already formed precipitates. As a rich or exclusively flesh diet promotes the formation of renal sand, especially uric acid, simple and easily digestible foods should be substituted, with active out-of-door exercise. The medicinal remedies of greatest value are alkalies and alkaline salts, as the bicarbonate of soda, carbonate of potash, carbonate of lithia, or the mineral waters of Vichy; they must not be taken in such quantities as to render the urine alkaline; otherwise earthy phosphates will be precipitated. If, however, the concretion forms in the kidney, efforts must be made to relieve its effects. The paroxysms of pain must be relieved by opium or its salts; the hypodermic injection of morphia is generally most serviceable; an enema of laudanum is often useful, with anodyne applications. Extreme heat, as a very hot brick, heated sand, or salt bag, or bottle of boiling water, well wrapped, is very soothing; an anæsthetic may occasionally be necessary; chloral, with morphia, sometimes acts very favorably. Should the presence of the stone cause suppuration, with a well-defined tumor, the pus must be early evacuated, at first by aspiration, and then by incision, as in the case of perinephritic abscess. But the still more important operation of nephrotomy, incision of the kidney, for the removal of the stone, must now be duly considered, and even extirpation of the kidney may become justifiable.

5. **Hydronephrosis** [1] consists of a dilatation of the pelvis of the kidney and subsequent more or less extensive disappearance of the renal parenchyma, due to obstacles to the escape of the urine in any division of the urinary passages; it may be congenital and non-congenital, the former being due to malformations, and the latter to concretions wedged into the pelvis or the ureter, or pressure from various causes upon the urinary track. The symptoms depend upon the grade of distention, and the invasion of one or both kidneys; if the obstruction is considerable, and especially if both organs are involved, the symptoms are those of embarrassed, diminished, or arrested activity of the kidneys, namely, acute or chronic uræmia. The tumor caused by distention of the kidney may attain a very large size, is generally unilateral, and occupies the loins, extending to the vertebral column, and often upwards into the hypochondrium, downwards into the iliac region, and forward to the umbilicus; it is soft, dull on percussion, distinctly defined by palpation, gives a distinct sense of fluctuation, is not movable, generally painless, and causes no feeling of inconvenience except that of weight and tension; if caused by nephrolithiasis, there will be attacks of renal colic, with bloody urine. The disease may be diagnosed from ovarian cysts by rectal examination with the hand, and from other tumors by the method of exclusion. The treatment in the early stages is expectant; where, however, the tumor is large and affects the health, as by embarrassing respiration, it may become necessary to remove the fluid; this has been effected by repeated kneading of the tumor which resulted in the escape of a large quantity of urine, and apparent recovery.[2] Usually, evacuation is best effected by aspiration, but the operation is not free from danger.

Fig. 495.

The aspirator is designed to remove fluids from cavities by means of capillary tubes and a suction-pump, so as not to leave an open wound nor admit air to the cavity. Various forms of aspirators are now in use which answer every purpose, but none are as thoroughly effective as that originally introduced into practice (Fig. 495).[3]

[1] W. Ebstein. [2] Roberts. [3] M. Dieulafoy.

It consists of a glass cylinder, *a*, about seven inches in height, and two in diameter, partly covered with a silver-plated casing, and having a tightly fitting piston which is raised or lowered by turning the handle, *b*. Near the bottom of the cylinder are the induction and eduction openings, *d c*, fitted with rubber tubes. The capillary tubes or trocars are six in number, and of different sizes; one is shown attached to the induction-tube, *d*, and five below the instrument. In addition to these there should be two or three small blunt canulas with trocars and a detachable handle, so that when the trocar is withdrawn the canula may be attached to the instrument. In using the instrument, the cocks, *c d*, are closed, and the handle, *b*, turned, producing a nearly perfect vacuum in the cylinder; the piston is held in raised position by a spring, *e*. The trocar is introduced with a rotary motion into the part from which the fluid is to be withdrawn; on opening the cock, *d*, it flows into the cylinder, which is emptied when full by closing *d*, opening *c*, pulling out the spring, *e*, and lowering the piston; when this is done, both cocks are again closed, and the operation repeated. The cylinder is provided with a scale graduated to grams, for showing the amount of contained fluid, and a glass tube is inserted near the outer end of the induction-tube, through which the fluid may be inspected. Very cheap and simple aspirators may now be obtained, which are portable, and will answer in ordinary cases. Perhaps the most simple instrument which the practitioner can employ for aspiration consists of several sizes of needles to which the syringe with a rubber tube and bulb [1] is fitted; the needle being introduced into the cavity, with the tube drawn over its outer extremity, by squeezing the bulb the fluid is forcibly and rapidly drawn out.

The point selected for aspiration will depend upon the size and form of the tumor. In general, the space between the eleventh and twelfth ribs gives the most direct access to the cavity of the tumor, and is least liable to involve the peritoneum.[2]

The cavity has been opened by incision;[3] two trocars were introduced near together and allowed to remain four days; on the third day urine flowed by the side of the canula, and on the fourth a chill occurred; an incision was now made between the trocars,[4] which were removed, the fluid evacuated, and drainage established, with carbolic acid dressings; death took place on the sixth day; the kidney has also been extirpated for this disease,[5] but with fatal results.

CHAPTER XLVIII.

THE URINARY BLADDER.

During infancy the bladder is pyriform and lies chiefly in the abdomen, but in the adult it is situated in the pelvic cavity behind the pubes; in the male it is in front of the rectum, and in the female the uterus and vagina are interposed between it and the rectum.

When quite empty the bladder lies deeply in the pelvis, when moderately full it is still in the pelvic cavity and has a rounded form, and when completely distended it rises above the brim of the pelvis and becomes egg-shaped; the base is directed towards the rectum in the male, and the vagina in the female, and

[1] Davidson. [2] J. Thompson. [3] Maas. [4] Simon. [5] Schetelig.

the smaller end or summit rests against the lower part of the anterior wall of the abdomen: the anterior surface is entirely destitute of peritoneum, while the posterior is covered by the peritoneum, which is prolonged upon the base; the distended bladder has its long axis inclined upwards and forwards in a line from the coccyx to a point between the umbilicus and pubes.[1]

I. EXPLORATION.

The cavity of the bladder may be explored to determine (1) its fluid contents, with catheters; (2) its solid contents, with sounds; (3) the changes in its mucous lining, with the endoscope.

1. **The catheter** is a tube composed either of metal, or soft material; the former is inelastic, while the latter is flexible. In practice, the metallic catheter is now seldom employed to draw off urine, for with the improved gum catheter this is done more safely, speedily, and conveniently.[2]

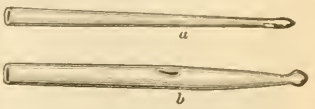


FIG. 496.

The gum-elastic catheter is made of every needful size, and may have a rounded, *a*, or an olivary extremity, *b* (Fig. 496). Its great advantage over the metallic instrument is, that ordinarily there is no great skill required in using it, and no danger is to be apprehended of lacerating the mucous membrane.[2] The soft rubber catheter is a perfectly harmless instrument, even in the hands of patients, and is adapted to cases in which the urethra has an irregular course.

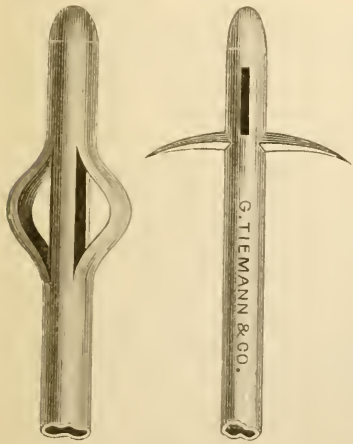


FIG. 497.

In selecting a metallic instrument, the following facts should be borne in mind;[3] the instrument should be made of silver, and curved so as to be exactly adapted to the natural curve of the urethra in its least movable portion, which may be supposed to have its axis in the centre of the symphysis pubis;[3] this curve is equal to a portion of a circumferential line, equal to about three tenths of a circle three inches and a quarter[4] in diameter. It is also important that the direction of the axis of the point should be at right angles to that of the shaft, whatever may be the length of the curve;[3] the operator can then always determine exactly the position of the point, however deeply the instrument may have penetrated. The handle of the instrument should have a ring on each side, near the external extremity, which are useful as guides to the position of the instruments, as aids in detecting obstructions, and as means of securing the instrument in the bladder. The

[1] Quain's Anat. [2] J. W. S. Gouley. [3] Sir H. Thompson. [4] Briggs.

eye should not be so large as to catch the mucous membrane. The gum catheter takes many forms adapted to special conditions; it may be made self-retaining by enlargements, or projections on its internal extremity (Fig. 497).

The introduction of the catheter, although apparently very simple, is one of the nicest and most delicate processes in surgery.[1] Proceed as follows (Fig. 498): place the patient in the recumbent position, with the head and shoulders slightly elevated by pillows, the knees a little raised and separated from each other to relax the muscles of the abdomen and perineum; standing or sitting on the left side of the couch, with the left hand support the penis, grasped by the thumb on one side and the fore and middle finger on the other, or with the palm upwards raise the penis between the ring and middle fingers applied just behind the corona glandis; with the thumb and the fore and middle fingers of the right, seize the catheter, warmed and well smeared with oil or vaseline, and insert the point into the urethra; the instrument at this moment is nearly horizontal, the concavity of the curve looking towards the left groin of the patient; the instrument should be slowly carried onwards until four or five inches have disappeared, the fingers of the left hand gently drawing the penis over the instrument as it glides easily to the bulbous part; the handle should meantime gradually approach the median line, but still be maintained in the horizontal position; if there is any obstruction in the healthy urethra it occurs at the triangular ligament, where the end of the instrument passes along the floor of the bulb; withdraw the catheter half an inch, and elevate the point with the fingers of the left hand in the perineum; now elevate the handle perpendicularly, carry it steadily over, as the catheter passes along the fixed curve, and depress the handle between the thighs, as the extremity enters the bladder; a slight rigor, an expression of distress, the freedom of the point, and the flow of urine

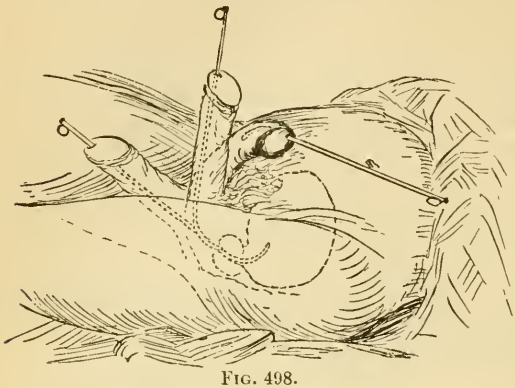


Fig. 498.

[1] S. D. Gross.

prove that the catheter has reached its destination. In removing the catheter, give to the handle the same curve reversed.

It sometimes happens that the part is extremely sensitive, and resists any but gentle efforts to traverse it, the more so if it be the first time an instrument has been introduced; the involuntary fibres close upon it as if to repel the intrusion, and the perineal muscles are prone to contract on the approach of the unwonted stimulus; some persons always exhibit this involuntary resistance, even when they have become in a measure habituated to the use of a catheter; in such cases no violence is to be used, as any attempt to force a passage would only increase the difficulty; gentle pressure, steadily maintained, without any poking or jerking of the point, or relaxing of the hand at one moment and increasing its power at another, will sooner or later carry the instrument through.[1]

2. **The sound**, *a*, *b* (Fig. 499) for exploring should be of solid metal, in order to give a clear note when it strikes the foreign body. Its curved part, or beak, should be little more than an inch long, and have more of a tendency to form an angle with the shaft than exists in the catheter; it may be hollow, and thus enable the operator to inject water into the bladder, or withdraw it, without change of instruments.[1]

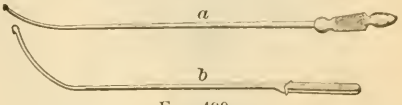


FIG. 499.

3. **The endoscope** is not serviceable, and is now rarely used in the examination of the bladder of the male;[2] it has a limited value in examination of the bladder of the female.

II. MALFORMATION.

Extroversion of the bladder[3] is a congenital malformation, occurring chiefly in males, in which the anterior portion and the parietes of the abdomen are absent, so that the posterior and lower part of the bladder protrudes under the pressure of the viscera from behind as a round, red tumor, covered by mucous membrane, in which the orifice of the ureters can be seen.

The linea alba bifurcates at the upper angle, but is continued on either side of the ossa pubis, forming a triangle; the pubic bones are not united by a symphysis; the penis is small, the urethra and corpus spongiosum are deficient in their whole extent, and the only remnant of the urethra is a groove lined by mucous membrane on the dorsum of the penis; the glans penis is full and large, and the prepuce is usually of full size, but cleft above. In the female there is no urethra nor clitoris, but the mucous surface of the bladder is continued directly down into the vagina.

This deformity leads to painful and distressing results, owing to the constant flow of urine over the groin and thighs, but it is in no

[1] Sir H. Thompson. [2] J. W. S. Gouley. [3] T. Holmes.

respect dangerous to life. The treatment may be palliative, by the application of an apparatus to collect the urine, of which there are many kinds. But even the best fitting does not always obviate the gradual soaking by urine of the skin of the abdomen, groins, and perineum; and hence operations have been devised to relieve the disgusting deformity. Efforts have been made (1) to open communication between the ureters and the rectum,[1] but the operation is very dangerous, and has not given satisfactory results; [2] (2) to cover the exposed surface; some of these operations have been very successful, and have become legitimate by the approval of good authority.

The most successful operations are as follows: Make an umbilical flap, 1 (Fig.

Fig. 500.

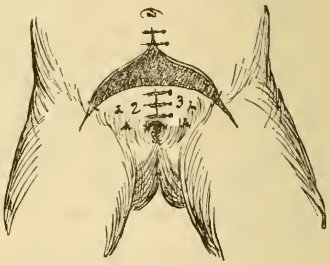


Fig. 501.

500) [3] and turn it down over the bladder; then make two flaps from the groin, one on either side, 2, 3 (Fig. 500), and slide them over the central flap, and attach them in the median line (Fig. 501); [4] the result is, the skin surface of the middle flap presents to the bladder, and the raw surface is covered by the raw surfaces of the lateral flaps; the new wound is left to cicatrize. Or, make a curvilinear incision [5] (Fig. 502) from the outer side of Poupart's ligament 4, 4 (Fig. 502) downwards below the scrotum to the middle of the perineum, and thence along the opposite side to a point corresponding with the first incision; dissect up this flap, 2, to the root of the penis, 3, and make a valve-like incision, through which it may be drawn; now make one transversely across the abdomen, 1, and dissect up a trap-door flap; invert the lower flap, 2, so as to bring the skin surface in contact with the mucous wall of the bladder; bevel the edges of the lower flap, and bring it under the trap-door flap by means of the tongue and groove suture, 5.[6] Or, dissect off the mucous membrane of the exposed bladder; make lateral flaps from both inguinal regions (Figs. 503, 504); unite

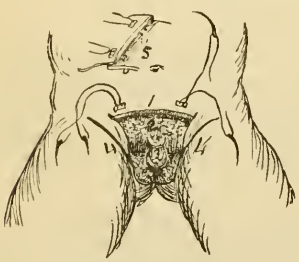


Fig. 502.

[1] J. Simon. [2] F. Jourdan. [3] Richards; D. Ayres; J. Wood. [4] J. Wood. [5] F. F. Maury. [6] J. Pancoast.

them upon the median line and transversely above it; the points A, A, A, and B, B, being brought together, as the skin more readily yields in a direction obliquely upwards; the result is perfect (Fig. 504).[1]

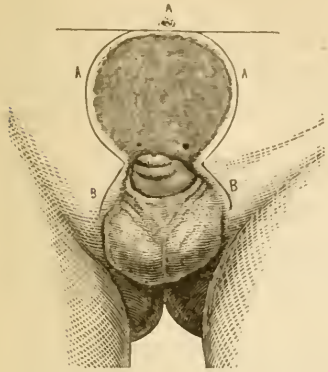


FIG. 503.

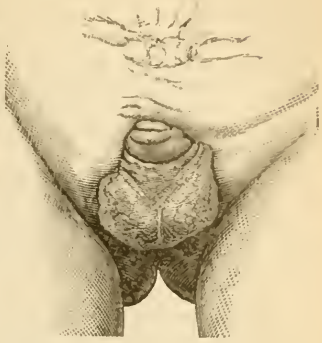


FIG. 504.

III. INJURIES.

1. Rupture of the bladder may be caused by (1) external violence, as direct blows, or falls, or crushing injuries; (2) muscular efforts, as in straining to pass water through an obstructed urethra, or during parturition; (3) thinning or ulceration of the walls of the viscus.

The rupture usually occurs when the organ is more or less distended, and the rent may be in the posterior walls covered with peritoneum, the contents of the organ escaping into the peritoneal cavity, or in the anterior walls, the extravasation taking place into the connective tissue.

The symptoms depend upon the direction which the urine takes; if it escape into the peritoneal cavity, there is generally sudden pain in the lower abdomen and a desire to void urine; this effort usually aggravates the pain without accomplishing the purpose, though sometimes a small amount of water tinged with blood has been passed, and even with considerable force. Shock follows, which may prove fatal, but usually passes off, and reaction comes on with high fever, increased pain in the abdomen, and tympanitis; the desire to urinate diminishes, uræmic poisoning supervenes, and the case proves fatal within a few hours to four or five days.

If the extravasation is into the connective tissue, the immediate symptoms may be very slight, and it is not until the urine has penetrated to some extent, and its corrosive effects are felt, that they are well marked. A diffused swelling

[1] H. J. Bigelow.

appears about the perineum and above the pubes; a low form of fever sets in, with typhoid symptoms; pain is not much complained of; the swelling extends in the subcutaneous tissues with a dusky redness, the surface is œdematous, the typhoid symptoms increase, and the patient dies, poisoned by the septic matters. The diagnosis is aided by the introduction of the catheter; if the rent is into the peritoneal cavity, the catheter passes readily into the bladder, withdraws a small quantity of bloody urine, and sometimes can be carried through the opening into the abdominal cavity; if the rent is in the anterior wall, a larger quantity of urine will be found in the bladder; if the urethra is torn, the catheter will be arrested before it reaches the bladder.

The treatment of rupture into the peritoneal cavity should be, in its early stage, by cystotomy, for the purpose of affording a direct outlet for the urine as it enters the base of the bladder. The method of opening the bladder should be that of lateral lithotomy, and the external wound should be maintained entirely free until the internal rent is closed. Recovery has followed the timely performance of this operation.[1]

It is undoubtedly of immense importance to remove the urine from the peritoneal cavity and cleanse and disinfect it, and an unsuccessful attempt has been made to effect this object by incision through the abdominal walls, closing the rent in the bladder by suture, and cleansing the cavity.[2] It would seem more rational to perform cystotomy first, to secure free escape of the secreted fluid, and then cleanse the cavity by incision made antiseptically; or to cleanse it by repeated injections of carbolized fluids and aspiration of the fluids injected through the same canula.[3]

If the extravasation is through the anterior wall, the swelling will first appear above the pubes, the fluid being forced in that direction by the deep fascia. Incisions should be made in the middle line of the perineum through the deep fascia, and the finger, introduced to the bottom of the wound, should gently force a passage towards the suspected point of rupture, for the purpose of opening a new and direct route for the escape of the urine; incisions should also be made into the external swelling caused by the infiltration of urine. If the water readily drains away by catheter, this instrument should be retained in the bladder.

2. **Wounds of the bladder**, by puncture or incision, are very rare,[4] but shot wounds are not infrequent in military practice. Though dangerous, the latter wounds are by no means fatal.[5] The chief points which demand attention in the treatment, especially of shot wounds, are (1) to prevent urinary extravasation into the neighboring parts; (2) to subdue inflammation; (3) to remove foreign bodies, especially those which may chance to lodge in the cavity of the organ.[5] If the wound is on the surface, uncovered by the peritoneum, the outflow may generally be effected by rest in the best

[1] Walker; E. Mason. [2] A. Willet. [3] J. W. S. Gouley. [4] G. A. Otis. [5] J. A. Lidell.

position for drainage through the external wounds and through the catheter retained in the bladder, the catheter being of soft rubber and self-retaining; if these means do not succeed, the bladder must be opened at its most depending part by lateral lithotomy; if the wound is through the peritoneal surface, cystotomy is immediately necessary. The resulting inflammation is best controlled by rest, and opiates in doses which secure perfect quiet. Foreign bodies, as cloth and balls, may often be removed through the urethra; if bodies are of large size, or angular, the bladder should be opened by median lithotomy.

IV. INFLAMMATION.

The painful and tedious inflammations of the bladder have their basis in a peculiar hyperæmia of the mucous membrane. At first they are excited by local irritants, or obstructions to the outflow of the urine, but subsequently they are greatly aggravated by the action of the muscles. This is due to that peculiar arrangement of the arteries and veins of the lining membrane, by which the contraction of the muscles does not affect the afflux of blood through the arteries, owing to their strong connective-tissue sheaths, while it greatly retards the efflux of blood through the veins which are not thus protected,[1] and hence are unduly compressed. As a result, the mucous membrane becomes so loaded with blood as to assume a dark purple color, thickened and velvety; in some cases coated with adherent lymph and phosphatic deposits from the urine, in others, ulcerated.[2]

1. **Acute cystitis** is very rare, and usually occurs when a urethral inflammation extends to its neck, or some injury is inflicted, or an irritant enters the bladder, as a rough foreign body, or a chemical substance. It always commences on the mucous surface; the irritation produces frequent and spasmodic muscular action, which leads to muscular hypertrophy, a constant phenomenon of cystitis. The symptoms are fever, great pain in passing water, frequency of micturition, bloody urine soon becoming purulent, pain and tenderness on pressure in the region of the bladder, and pain extending down the thighs and perineum. The treatment consists (1) in the removal of the exciting cause, if that can be determined, and of every possible source of irritation; for this purpose the patient should be kept quiet in bed, and drink freely of demulcent fluids, with alkalies, as soda or potash, which tend to dilute the urine and render it unirritating, if very acid; (2) the local hyperæmia must be relieved by leeches to the perineum, and, in very severe cases, hot hip-baths and warm fomentations; (3) the muscular spasm must be controlled by anodynes; opium by the rectum, as enemata or suppositories, is

[1] E. Rindfleisch. [2] T. Holmes.

invaluable; or hyoscyamus, in large doses, may sometimes be preferable; or morphia injections into the bladder.

2. **Chronic cystitis** [1] never occurs as an idiopathic affection, but invariably arises from other morbid conditions of the urinary passages, as prostatic and urethral diseases, stone, morbid growths in the bladder or rectum, decomposing urine retained from any cause. The symptoms are those of acute cystitis, modified by the grade of inflammation, but the urine always contains pus. If the cause is removed and the symptoms continue, the treatment must be palliative, namely, suitable hygienic conditions, and the injection of anodyne and disinfectant solutions, as morphia, with carbolic acid. One of the most important features in this treatment is irrigation of the inflamed surface with weak carbolic solutions;[2] this may be done by means of the catheter and syringe, the best syringe being the rubber bag, with a tapering nozzle and stop-cock; or the fountain syringe, with the necessary apparatus, may be used as follows: —

To the fountain syringe bag (Fig. 505) holding a pint, and tube of variable length, so as to allow, if desirable, considerable pressure by elevating the bag, is attached a two-way stop-cock (Fig. 506); upon the tube is another stop-cock only useful when it is desired, having thrown a medicated solution into the bladder, to retain it there for a certain length of time without either allowing to become over full, or its contents to escape; the nozzle of the nickeled stop-cock is very large, nearly a quarter of an inch in diameter, and fits snugly into the expanded conical (also nickeled) mouth-piece; it is so large, and fits so easily, that the most clumsy fingers can readily adjust it almost unaided by sight; upon this conical catheter mouth-piece is fitted a thin piece of rubber tubing covering its upper two thirds; this allows the mouth-piece to be used with any metallic or other hard catheter, and prevents leakage; the fine conical point or the mouth-piece is to be screwed into any soft catheter before introducing the latter; the other branch of

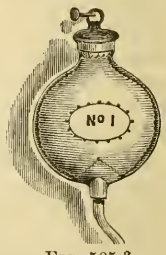


FIG. 505.[3]

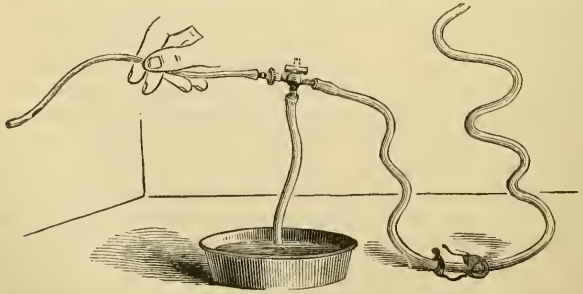


FIG. 506.[3]

[1] Van Buren and Keyes. [2] T. S. Wells. [3] G. Tiemann & Co.

the two way stop-cock is fitted into a short piece of rubber tubing which conveys the urine and the washing into some convenient receptacle.

In obstinate cases, which resist all treatment, cystotomy has been performed with marked relief to the suffering.[1]

V. RETENTION OF URINE.

Inability to discharge the water accumulating in the bladder results in gradual distention of the organ; the cause may be stricture of the urethra, enlargement of the prostate, or paralysis of the muscular coats. The viscus distended appears above the pubes as an oval body, distinctly defined to the touch, and gives a flat percussion note; the finger in the rectum detects a globular tumor pressing into the lower pelvis, which often has a sense of fluctuation when percussion is made externally. If the cause is paralysis, a catheter must be frequently passed, and the bladder should be washed out with slightly carbolized water. If obstruction exists which cannot be relieved, the bladder must be punctured. The aspirator now affords the best means of withdrawing the fluid. The common bulb syringe[2] may be attached to the large aspirating needle and the evacuation readily effected. Enter the needle just above the pubes, first making a slight cut through the integuments; the operation may be repeated at this point many times without danger, provided the bladder is so much dilated as to rise well above the pubes. Puncture with a small trocar and canula may be made at the same point. Puncture by the rectum is sometimes resorted to as follows: Select a small, long, curved trocar with silver canula: after the action of an enema, place the patient on the back, with the thighs flexed; introduce the forefinger of the left hand into the rectum, until the tip rests upon the posterior part of the prostate; carry the point of the trocar behind the finger, and when it reaches the bladder thrust its point forward in the direction of the centre of the pelvic cavity; withdraw the trocar, and when the urine has all escaped insert a cork in the canula and retain the latter by a bandage; if the bladder cannot be distinguished, puncture should not be made.[3]

VI. FOREIGN BODIES.

Substances introduced into the bladder through the urethra may be of every variety of structure and consistency. Whatever may be their nature, they tend to form nuclei for the deposit of the urinary salts, and either by themselves, or by the concretions formed, become sources of severe irritation of the bladder. The symptoms are those of vesical irritation from stone, namely, pain, obstruction to the free passage of urine, and evidences of cystitis. The pres-

[1] W. Parker. [2] Davidson. [3] Van Buren and Keyes.

ence of a foreign body may be acknowledged by the patient, or discovered by exploration of the bladder. If the foreign body is discovered it must be removed, and in such manner as to create the least possible injury to parts. The most serviceable instrument for general use, as in the removal of a portion of catheter, pin, bead, slate-pencil, small stone, is the lithotrite (Fig. 507).[1]

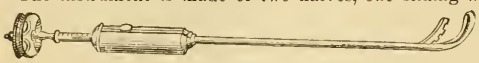


FIG. 507.

The instrument is made of two halves, one sliding within the other, and is of the shape of an ordinary catheter when closed; it is introduced into the bladder by the urethra; then, by means of a screw or rack and pinion worked on the outer extremity, the movable part is made to slide back within the bladder, now forming two jaws, by which the body is seized; by turning the screw or handle, the blade is propelled onward, and the substance is firmly held and compressed, if possible, so as to admit of being removed readily by the urethra.

Introduce it, and seize the body with the jaws of the lithotrite, and in such manner as will present its long axis to the long axis of the urethra. The exact position of the foreign body having been determined, place the beak of the instrument in immediate contact with it; now open the jaws by turning the screw, and when sufficiently separated give the beak a slight lateral movement and turn the screw so as to close the jaws; if the object is seized, the position of the screw will indicate its size. If, on attempting its withdrawal, the body cannot be engaged in the urethra, the instrument must be loosened and the body seized again with a view to change its diameter. If all efforts at extraction fail, the bladder must be opened by median lithotomy, and the body removed.

VII. CALCULUS

Vesical stones result from the accretion of the salts of the urine around a nucleus. This central body is generally sand or gravel which descended from the kidney; but it may be any insoluble substance forming in the bladder, as mucus, or introduced from without, as a pin. These stones vary in composition according to the constituents of the urine in each case. Two sources of origin are recognized, namely: (1) from the organic elements, of which urea and uric acid are the most frequent; and (2) from the inorganic constituents, the salts of the urine, of which the phosphates are most important.[1] The symptoms are pain at the neck of the bladder, along the urethra, and under the glans penis; increased frequency of desire to void urine, with spasmodic pain at the close of the act; blood in the urine at the close of urination or after severe exercise; sudden arrest of the stream of urine while in full flow, with strong spasmodic

[1] Sir H. Thompson. [2] A. Poland.

contractions at the neck of the bladder attended by severe pain.[1] But the diagnosis must finally rest upon the detection of the stone by the sound. A patient suspected of having a stone should be subjected to a course of treatment preparatory to sounding, such as rest, regulation of the bowels, the use of diluents, tonics, and nutritious diet; the first exploration should be made with soft bulbous bougies, to estimate the calibre of the urethra and its sensitiveness; the second examination should be made in not less than two days with a searcher of abrupt curve and short beak (Fig. 507).[2]

When the sound enters the bladder it must be moved to and fro, to the right and left, and then reversed; large stones usually lie close to the vesical neck, and are readily felt, but medium and small-sized calculi are more apt to be found in the posterior part of the bas-fond on either side of the median line; the contact of the instrument with a calculus will determine by the note whether it is hard, soft, or encysted.[3]

The various operations for the removal of stone from the bladder are arranged under two heads, namely, lithotrity, by which the stone is crushed in the bladder and removed through the natural passages without cutting; and lithotomy, by which the stone is removed through an artificial opening made into the urethra or bladder.[3] Very marked differences of opinion exist as to the relative merits of the several operations embraced under these two heads. The special adaptation of each operation will be specified so far as it has been determined.

The management of vesical stones strikingly illustrates the truth previously emphasized, that good judgment is quite as important as operative skill; but to attain the best success the two should go hand in hand. There is no exclusively best method of dealing with these foreign bodies, and there is no particular method applicable to all cases even of a kind, for experience teaches that one patient will bear immediate surgical operation, be it lithotomy or lithotripsy, while another of the same age, and apparently in the same state, will be killed by precisely the same treatment; the judicious surgeon, therefore, will select from among the many known operative procedures the one which is indicated after due consideration and study of all the peculiarities of the individual case.[2]

1. **Ordinary lithotrity** aims first at reducing the stone to a condition in which it will least injure the mucous membrane and be most readily expelled from the bladder, namely, that of powder; and, second, to effect this object by the smallest amount of instrumental interference.[3] It is especially indicated when the general condition of the patient is good, the urethra capacious, the bladder tolerant of instruments, and the stone is found of medium or small size and soft; it may be applied to children when the stone can be destroyed at one or two sittings, and is very successful in old men with enlarged prostates.[2]

[1] Van Buren and Keyes. [2] J. W. S. Gouley. [3] Sir H. Thompson.

The principal evils arising from the practice are traceable to the inflammation of the bladder and urethra, almost invariably caused either by instrumental examination, or the presence of sharp or angular fragments; the aim of the operator, therefore, should be to reduce the stone to a condition in which it will least injure the mucous membrane, and be most readily expelled from the bladder with the smallest possible amount of instrumental interference; these principles are to be constantly kept in view in the selection of instruments, and in the numerous details connected with the operation [1]

The lithotrite should be so constructed that it will not become impacted, will have adequate power, and will be of easy manipulation. These features are now combined in an instrument (Fig. 508)[2] constructed as follows: the floor of the female blade *f*, is raised, and lateral notches added to the male blade, *e*, which is also provided with a

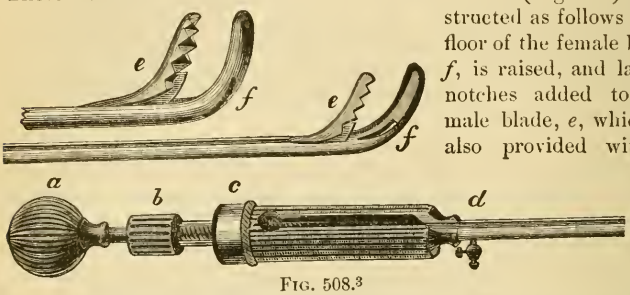


Fig. 508.[3]

central septum at the heel; the lateral grooves for the male blade extend through the heel of the female blade; the movement for locking a lithotrite is by a quarter rotation of the bulb, *a*, without displacing the fingers of either hand; as the rapidity of a lithotrite depends upon the inclination of its screw thread, and as the slowest screw gives most power and requires the strongest blades, in the longer and more rapid operation, larger and stronger blades than have been commonly employed, and which also better protect the bladder than do the latter, are desirable.

The blades of a lithotrite should be as nearly at right angles with the shaft, and their floor as straight, as is compatible with their convenient introduction into the bladder; many instruments are made with an oblique blade, which is also so rounded at the heel as to curve their floor; this is a mistake; a cubical stone, for instance, would exactly fit a right-angled lithotrite; but when the same blades are made oblique, at an angle, for example, of forty-five degrees with the shaft, then, in order to grasp the same stone, they must not only be opened wider, but they will touch the stone at points nearer the shaft than before, for the size of their grasp rapidly diminishes with their obliquity; they must be opened wider, and they seize less of the stone; their power also diminishes, because, if they are made longer with the view of retaining the size of their grasp, their increasing leverage increases friction in the slide; this is readily seen by increasing their obliquity until they reach the line of the stem of the instrument, when they tend merely to roll the fragment between them;

[1] Sir H. Thompson. [2] H. J. Bigelow. [3] G. Tiemann & Co.

the latter then acts only as a wedge to separate them, and the friction of the slide is then greatest; in other words, right-angled blades crush best and wedge least; oblique blades, on the contrary, wedge more and crush less, while the depth of their grasp is also less; and what is here true of the whole blade is true of any part of it — the heel, for example, which should not be oblique nor much rounded, but as nearly at right angles with the shaft and with as straight a floor as is compatible with its convenient introduction.[1] The tip of the female blade should be beveled, so that (if compared to a bent finger) it may impinge against the upper wall of the prostate, while passing it, rather with its pulp than with its nail.[1]

Before the operation efforts should be made to allay any existing irritation of the bladder by rest and anodynes, continued for several days. At the moment of operation the bladder should contain a moderate amount of water, either retained or injected. An anæsthetic is not required in the ordinary operation.

In passing the lithotrite,[1] the continuous sweep of the catheter will not be successful in carrying it into the bladder, as the terminal angular part constituted by the blades would thus impinge upon the anterior wall. It may happen that the meatus will not admit the instrument, when it must be incised in the direction of the frænum.

Introducing the point of the beak into the urethra,[1] the instrument and penis being held as in catheterism, carry it down to the triangular ligament; having reached this point, withdraw it slightly, and make traction on the penis to efface the depression of the floor of the urethra made by the end of the instrument; now guided by the bony arch above, pass the point through the ligament; the rest of the canal corresponds with the axis of the body and is generally easily traversed, the instrument being pressed through the indurated neck, or prostate, in the direction of the axis of the body, with the hand on the perineum, when the prostate is large; if there is doubt, the tip may be guided by the finger in the rectum; the straight tube, or the shaft of a curved one, now returns to an angle of about 45° with the recumbent body. When in the bladder, the lithotrite should first be used as a sound, the blades being closed; pass the extremity from point to point, over the internal area, systematically exploring one region after another, in orderly succession, until the object is found, or the entire area of the bladder has been thoroughly examined.

In this exploration the instrument should not only be lightly thrust forward at every point, in order to strike with some force the object, but also turned rapidly with the fingers on its own axis from side to side, to enable the beak to detect anything situated laterally.

When the stone is felt, a slight lateral movement of the blades determines on which side it lies; incline the blades away from it and

[1] H. J. Bigelow.

pass them towards the posterior wall, while the male blade is unlocked and withdrawn; then incline the blades towards the stone and slowly close them upon it (Fig. 509).[1] Or, the blades may be passed to the most depending part of the bladder (Fig. 510), and the male blade withdrawn with a view to enable the stone to fall between them; this object may be effected sometimes by a slight jar of the handle by tapping with the fingers.[2] The stone having been seized, the screw must be slowly turned until the grasp is firm; with the common lithotrite there is danger of seizing the mucous membrane, and such movements of the blade should be made as will prove that the instrument is free; grasping the handle firmly with the left hand, turn the screw with the right, until the stone breaks; withdraw the male blade, and without moving the instrument, again close them upon such fragments as fall between them; this act may be repeated several times, when the instrument must be withdrawn. The patient must be placed in bed and warmly covered, and five grains of quinine administered. The detritus must be allowed to escape with the urine, no efforts being made to remove it. The operation should not be repeated for three or four days, according to the condition of the patient.

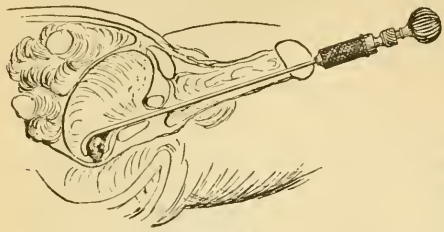


Fig. 509.

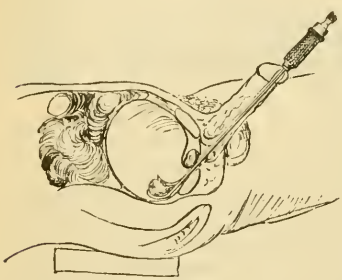


Fig. 510.

The following practical maxims[3] should be observed: (1) execute every movement deliberately; open and close, incline, or rotate, slowly, without any jerk whatever, and without bringing the blades, as far as possible, in contact with the walls of the bladder; (2) take care that the blades reach or pass beyond the centre of the bladder before the male blade is withdrawn; (3) maintain the long axis of the instrument in the median line of the body and the blades at or near the centre of the bladder, this being the area for operating mostly to be chosen; in screwing home the male blade to crush it is especially necessary to keep the instrument steady, for a small deviation of the handles produces a large one at the blades; (4) when the stone is caught, especially in the fenestrated lithotrite, rotate it a fourth of a turn on its axis before crushing

[1] M. Civiale. [2] B. C. Brodie. [3] Sir H. Thompson.

to make certain that nothing is included besides the stone; (5) having broken the stone, the fragments fall immediately beneath the instrument, where they may be seized without searching, and crushed, if the instrument is carefully worked, exactly in the same spot, the patient not moving; (6) never withdraw the lithotrite loaded with calculous débris; (7) the large majority of sittings should occupy but three minutes, and no sitting should exceed five minutes, except under peculiar circumstances; (8) after the first sitting it is generally desirable that the patient should have hot fomentations to the hypogastrium and perineum, remain in bed, and pass his water in the recumbent position, until the débris has passed, which usually requires three days.

2. **Litholapaxy**[1] is the immediate removal of the débris created by the lithotrite; this operation is advocated on the ground that when the operation is prolonged through several sittings, the stone being broken into fragments, which could be only in part removed through the imperfect evacuating apparatus employed, the subsequent vesical irritation is more largely due to these fragments than to the instrument; hence the necessity of crushing the stone, pulverizing its fragments, and with an efficient evacuating apparatus removing the fragments and the detritus at a single operation, though it may be indefinitely prolonged.

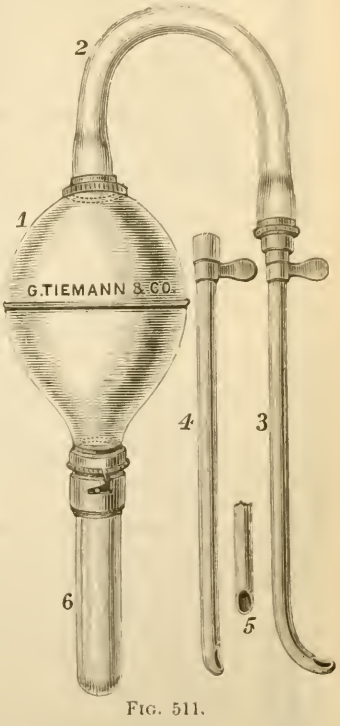


FIG. 511.

Rapid lithotrity has thus far given a larger mortality than the old method, being ten per cent. of the former,[1] to eight per cent. of the latter.[2] It will, therefore, be prudent to discriminate in deciding to adopt this method. It seems best adapted to those cases of lithotrity which have very large urethræ, a slight amount of vesical irritation, and no organic disease of the kidney.

The important instrument required in this operation is an efficient evacuating apparatus. This consists of the following parts: (1) an elastic bulb; (2) a rubber tube two feet in length; (3, 4, 5) evacuating silver tubes of large calibre, straight or curved quite near the extremity; (6) glass receptacle. The calibre of the evacuating tube should be 28 to 31, or even 32 French scale, for upon its size depends its efficiency. The receiving extremity should depress the bladder, and thus invite the frag-

[1] H. J. Bigelow. [2] Sir H. Thompson.

ments, while its orifice remains unobstructed by the mucous membrane; the best orifice is at the side of the extremity, and is made by bending the tube at a sharp angle, rounding the elbow, and cutting off the bent branch close to the straight tube; the tube is then practically straight, while its orifice delivers a stream at an angle. The obstructions of the tube are readily recognized by watching the expanding of the rubber bottle with a dimple in its side; if this remains stationary for a moment, a fragment fills the orifice, and must be expelled by compressing the bulb.

The operation is performed as follows:[1] Place the patient on a firm table and give ether; inject eight to ten ounces of warm water into the bladder, or sufficient to render the walls moderately tense, the capacity of the organ having been previously determined; introduce the lithotrite, and wind a tape or elastic band around the penis to retard the escape of the water, and if too much escape inject more through the lithotrite; seize and crush the stone, and repeatedly crush the fragments; withdraw the lithotrite, and introduce the tube of the evacuating apparatus, the proper amount of water being maintained; press the point gently to the base of the bladder, and if the elastic bulb is compressed release the grasp and allow it to dilate; a quantity of detritus falls to the bottom of the glass receptacle; when the bulb is dilated, repeat the manœuvre, forcing the water slowly into the bladder, and again releasing the grasp and allowing suction to be applied; if at any time the bulb cease to expand, a large fragment has entered the tube, and must be expelled by forcing the water out. If large fragments remain, the lithotrite is again introduced, the fragment crushed, and the evacuating catheter again employed. The single sitting has been prolonged from an hour to three and three quarters hours. The subsequent treatment is the same as the ordinary method.

FIG. 512.

3. **Perineal lithotrity**[2] is based on the extreme dilatability of the vesical neck without injury, and is adapted to large calculi in an irritable bladder, conditions unfavorable to lithotrity and lithotomy. It consists in opening the urethra by perineal incisions, dilatation of the neck of the bladder, crushing of the stone by forceps, and its immediate removal.

The special instruments required are a strong, straight, lancet-pointed bistoury, a six branched prostatic dilator, three or four lithoclasts of different shapes and strength, two or three pairs of small straight and curved forceps, a scoop, and a long-nozzled

[1] H. J. Bigelow. [2] Dolbeau.

rubber syringe. The dilator (Fig. 512) is composed of six uniform metallic branches held together by an India-rubber band; the vesical end is conical, and surmounted by a small metallic hood which covers the free extremities of the six branches, and fits in the groove of the staff; in the centre of the branches are two spheres attached to a stem which extends from the hood at the vesical extremity to terminate by a screw-thread in the handle; when the handle is turned the spheres are pushed forward from their concealed position, and the instrument is gradually developed.[1]

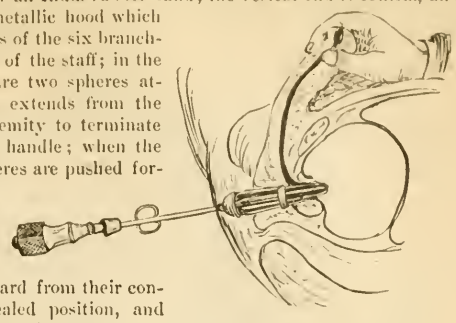


Fig. 513.

The operation is as follows:[1] the patient, properly prepared, is etherized and placed in the lithotomy position: the staff is held in position by an assistant; an incision a little less than an inch is made in the median line, extending to the anal margin, the skin, superficial and deep fascia, being divided, the left index finger nail is pressed into the groove of the staff, and the membranous portion punctured with the knife, the bulb and rectum being avoided; the urethra is incised about one fourth of an inch, and the extremity of the dilator introduced along the groove of the staff (Fig. 513), and methodical divulsion of the urethra begun; by this effort, the external wound and urethra are so enlarged that the closed instrument enters the prostatic portion, which is slowly dilated while the handle is depressed 130° to carry the point nearer the vesical neck; the dilator is again closed and advanced, the staff removed, and dilatation again slowly made; in this third step the introduction and opening of the dilator must be very slow, no violence being used, and when there is great resistance the process should stop for a moment, and then be slowly repeated, until the vesical neck admits the dilator; the instrument should be withdrawn open. The reduction of the stone, lithoclasty, is now practiced. The lithoclast (Fig. 514) is a powerful forceps of small diameter when closed, and admitting of opening

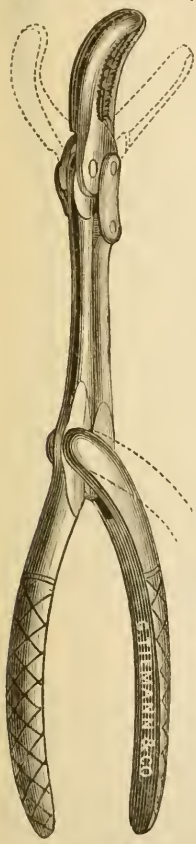


Fig. 514.

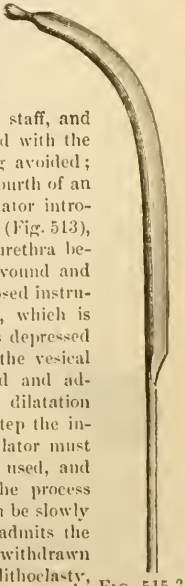


Fig. 515.[2]

[1] J. W. S. Gouley. [2] G. Tiemann & Co.

of the beaks without increasing the shaft, and in its improved form, with curved beaks, to admit of seizing stones behind the pubes.[1] The extraction of fragments is made with the lithoclast and scoop. The after-treatment is the same as for lithotrity.

4. **Median lithotomy**[2] is eminently applicable for small stones in a bladder which will not tolerate the use of instruments without chill or other disturbance; for multiple small stones in the adult; and for boys too young for lithotrity.[3] The instruments required are a staff, director, and knife. The staff has a broad, deep groove (Fig. 515);[4] but there are advantages in having a larger curve and deeper groove (Fig. 516).[5] A director (Fig. 517)[5] six inches long, with a flat, tapering groove and probe point, is very desirable to pass along the staff, after the knife is withdrawn, as a guide to the finger. The operation is as follows: The patient being properly placed and etherized, and the staff in the hand of an assistant, introduce the left index finger into the rectum, and place its extremity in contact with the staff so as to steady it; with the knife, pierce the perineum in the middle line about half an inch above the anus, or at such distance as will clear the fibres of the external sphincters (Fig. 518); carry the knife steadily and firmly on till it strikes the groove of the staff; now move the point of the knife along the groove a few lines towards the bladder, and then withdraw it, cutting upwards,[2] so as to leave an external incision of from three quarters of an inch to one inch and a half, according to the size of the stone; introduce the director (Fig. 517) along the groove well into the bladder, and remove the staff; pass the index finger of the left hand, well oiled, along

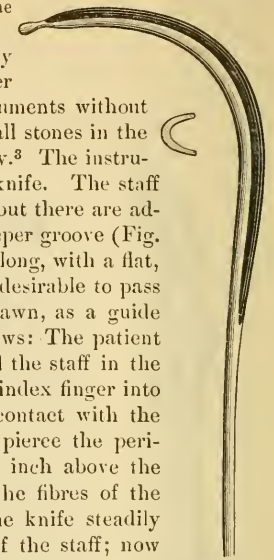


Fig. 516.[6]

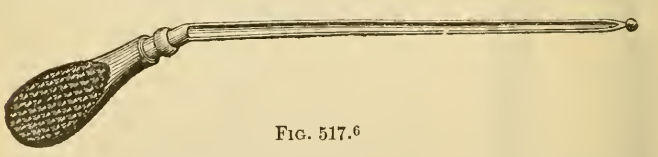


Fig. 517.[6]

the director, with a semi-rotary motion, through the prostate into the bladder; when the stone is free, it comes in contact at once with the finger, and passes into the wound on withdrawing the finger; the patient makes powerful expulsive efforts, which keep the stone in contact with the wound, where it may be seized with forceps; if the stone is larger than the finger, the opening must be dilated, or the

[1] J. W. S. Gouley. [2] G. Allarton. [3] Van Buren and Keyes.
[4] T. M. Markoe. [5] J. L. Little. [6] G. Tiemann & Co.

stone may be seized with a lithotrite and crushed; or, if very large, the wound may be enlarged by vertical or lateral incisions.

5. **Medio-lateral lithotomy** was devised [1] on account of the dangers of lateral lithotomy; the membranous portion of the urethra was opened upon an angular staff, and the prostate was divided laterally. The following method [2] is more easily executed, and is in other respects preferable: [3] The patient placed in the ordinary position for lithotomy, the staff in position, an incision is made in the median line of the perineum, from before backwards, and terminating two or three lines in front of the anus; from this point the incision is continued for a quarter of a circle around the left side of the rectum; the rectum is pressed back with the finger of the left hand aided by the knife; the left index finger is now passed into the rectum, and the knife, with its back towards the bowel, is passed at the posterior part of the central incision into the membranous portion of the urethra; the incision of the prostate is made from within outwards; in children, a single incision is sufficient, but in adults the circular part of the wound should be deepened before or after the urethra is opened; the forceps are now introduced, and the stone removed.

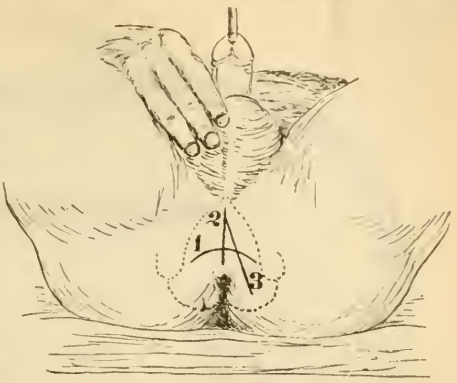


FIG. 518.

6. **Bilateral lithotomy** [4] consists of a transverse incision of the perineum and prostate to an equal extent on either side of the median line. The advantages claimed are [5] simplicity of operation; more direct access to the bladder; extent of wound admitting extraction of large calculi without unduly dividing the prostate. The special instrument required is a bisector, with a properly grooved staff [5] (Fig. 519). Operate as follows: [5] The patient being in the lithotomy position, and the staff held in the vertical direction by an assistant, make a semi-lunar incision, convex upward, from a point midway between the anus and ischium of the right to a corresponding point on the left side, passing about half an inch anterior to the anus, 1 (Fig. 518); the dissection is continued, until the nail of the left

[1] Buchanan. [2] H. Lee. [3] J. W. S. GOULEY. [4] Dupuytren. [5] J. R. WOOD.

index is placed in the groove of the staff in the membranous portion of the urethra; the urethra being opened, the knob of the bisector is placed in the groove of the staff (Fig. 519); the staff being

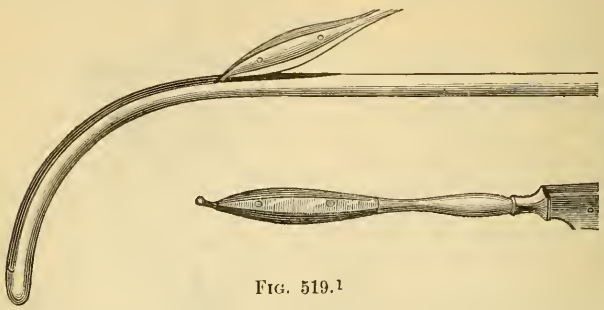


Fig. 519.[1]

depressed by the operator, the bisector is pushed through the prostate bisecting it; the finger is now passed along the staff into the bladder, the staff removed, and the forceps passed along the finger.

7. **Lateral lithotomy**[2] is so named from the lateral incision of the prostate gland and neck of the bladder.[3] This method is undoubtedly best in children, as the incision is not liable to injure the seminal ducts, a free outlet is afforded for the extraction of the stone, and there is little danger of peritonitis from violence, even with large stones; in the adult it is to be preferred for the removal of large stones, and where the stone is small or large when the bladder is more than ordinarily irritable and inflamed.[4] The instruments required are as follows: the scalpel (Fig. 520), a grooved staff (Fig. 521), a straight or beaked bistoury[5] (Fig. 522) or lithotome,[6] straight and curved forceps (Figs. 523 and 524), the scoop (Fig. 525) for the removal of fragments and as a conductor for the forceps in deep wounds.

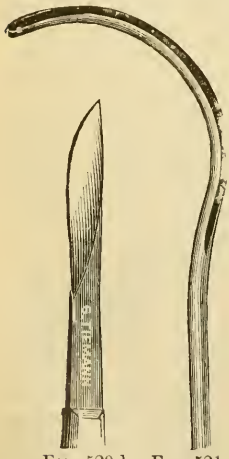


Fig. 520.[1] Fig. 521.[1]

Fig. 522.

Operate as follows:[7] Every care being taken that the patient is in favorable condition, the perineum should be shaved, an enema of warm water administered about an hour

[1] G. Tiemann & Co. [2] Franco. [3] S. Cooper. [4] Van Buren and Keyes. [5] W. Blizard. [6] Briggs. [7] Sir W. Fergusson.

before, and after its action the urine should, if possible, be retained until the operation ; place the patient, etherized, on the operating table, and introduce the staff, which should be as large as the urethra will admit with ease, and of such a shape as that delineated, having the groove presenting a little to the left side of the urethra; the instrument should, if possible, be made to strike the stone, and should then be given in charge of an assistant; the hips should be brought to the margin of the table, the staff held nearly perpendicular, with the concavity of the curve resting on the upper part of the triangular ligament, right side; sit in front of the perineum, having previously arranged with an assistant about having the instruments handed, or having already assorted them properly on a chair; pass the forefinger of the left hand, well oiled, into the rectum, to ascertain the size of the prostate, and the depth of this organ from the surface; trace the course of the rami of the pubes and ischium on the left side, ascertain the position of the tuberosity of the latter bone on each side, and having scanned the whole surface, proceed to use the knife, grasping it much in the manner of a common bistoury, but with the hand and instrument pointed directly to the perineum; enter the point about one inch and three fourths in front of the anus, 2 (Fig. 518), a line's breadth left of the raphé. push through the skin, and carry it by a kind of sawing motion down the left side of the perineum, about an

Fig. 523.

Fig. 524.

Fig. 525.[1]

inch beyond the anus, 3 (Fig. 518), the middle of the incision being at equal distances from the latter part and the tuberosity ; run the blade along the surface of the exposed fat and cellular tissue, and then thrust the point of the forefinger of the left hand into the wound a little in front of the anus, so as to penetrate between the accelerator urinæ muscle and the erector, — the knife being applied to any part which offers resistance; the finger can now be placed upon the membranous portion of the urethra, and the groove in the staff may be distinctly felt ; carry the point of the blade, with the flat surfaces

[1] G. Tiemann & Co.

nearly horizontal, along above the finger, and perforate the urethra about three lines in front of the prostate, and carry it along the groove until it has entered the bladder, having slit open the side of the urethra and notched the margin of the prostate in its course; slip the forefinger of the left hand slowly into the bladder along the staff, in such a manner as to cause dilatation of the surrounding textures, and move its point about in search of the stone, which, being found, should be retained in a position near the neck of the viscus; remove the staff, and introduce the forceps along the upper surface of the finger, slowly withdrawing the latter as the former makes progress; their entrance will be denoted by a gush of urine, at which instant the blades should be separated, when on gently approximating them the stone will, in all probability, be felt inclosed. If it is not, the process may be repeated, if the water still flows, but should the bladder now be empty, the closed blades should be quietly moved about the bladder until the stone is touched, and at this time, in opening and closing them, great care should be taken to avoid any injury to the bladder; extraction being effected, the operation is completed.

Unless the calculus be large and palpable, and well ascertained before, never cut into the bladder without feeling the concretion when the patient is on the operating table; in general, the staff suffices for all the sounding which may be required at this particular time.[1]

Before commencing the incisions, determine that the point of the staff has not slipped out of the bladder, and place it in the attitude in which it is to be held afterwards, and then give it in charge to the assistant; the length of the external incision in the adult should be about three inches; but if the patient is fat, the perineum deep, and the stone large, it should be made longer, at both ends, but more especially in front.[1]

A free division of the skin is a most important feature in the operation; but beyond this the application of the knife should be extremely limited; the point of the finger may, in general, be thrust without much force into the space between the accelerator urinæ and erector penis, provided the superficial fascia has been cut (Fig. 526).[1]

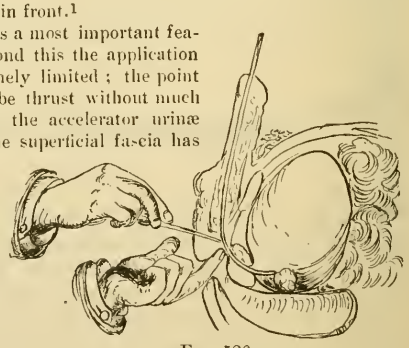


Fig. 526.

In a large majority of cases the opening in the deep part of the perineum and neck of the bladder need not at first be larger than what the forefinger will stop, and as the latter follows the course of the knife as soon as it is withdrawn, there will be as yet only a slight escape of urine; but when the forceps are used the fluid will gush out at once, at which time, as already stated, the stone may probably be seized, and thus further dilatation or the reapplication of the knife may be decided ac-

[1] Sir W. Fergusson.

cording to circumstances; it is rarely necessary to apply the knife again, for dilatation or laceration is safer than free incision into the tunics of the bladder beyond the prostate.[1]

The principal hazards[1] during the operation are, wound of the rectum or of some large blood-vessel; the former will be best avoided by keeping the knife, when in the deep part of the wound, chiefly above the finger, which may also be used to depress the gut. Under the age of puberty there is seldom any annoyance from hæmorrhage, but in the adult there may be both trouble and danger. The superficial perineal artery, or its transverse branch, is occasionally of such size, that, when divided, a ligature may be necessary; it is usually so near the margin of the wound that it can be secured with great facility. The artery of the bulb will seldom be cut, as the point of the knife should never be carried so high as this part. Perhaps the most troublesome hæmorrhage may be from the veins around the neck of the bladder, which, in those advanced in years, are often of considerable size. If necessary, the opening in the skin might be enlarged, to permit the application of a ligature to a deep-seated artery, and it might even be possible to carry a curved needle round the pudic, were this deemed advisable; but in the generality of instances the bleeding ceases as soon as the patient's thighs are placed together, — for then the cut surfaces come more closely into apposition.

Numerous instruments have been invented with a view to give greater precision to the manipulations of the operator. The most perfect instrument[2] is the following: —

It consists of a catheter and lithotome (Fig. 527). The catheter is bent nearly at right angles, with a rounded corner, having a strong handle, on the shank of which is fixed a hinge for the attachment of the incisor, which, when closed, strikes into a slot at the angle, which runs to the point and twists towards the left side; in the slot there is a cup attached to a band of spring steel, which runs through the upper part of the catheter, the base of the hinge, and the handle, to end in a knob, not shown in the cut. The incisor being opened, as in the cut, introduce the catheter, the angle of which makes a prominence in the perineum, behind the bulb of the corpus spongiosum; now press the incisor home, then withdraw it, and into the opening thus made introduce the point of the lithotome into the cup, when its forward motion will, if it has struck the cup, draw the knob to the end of the handle, which will indicate that it has engaged in the slot, and will follow it into the bladder, inclining to the left side as it passes deep into the tissues.

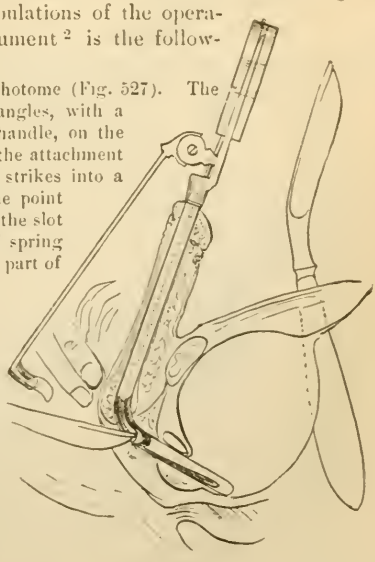


FIG. 527.

[1] Sir W. Fergusson.

[2] N. R. Smith.

The treatment after lithotomy, as regards diet, the state of the bowels, and the various evil consequences of the proceeding, not particularly referred to above, — such as infiltration, wound of the rectum, inflammation of the neck of the bladder or of the peritoneum, — should be conducted on the ordinary principles of surgery.

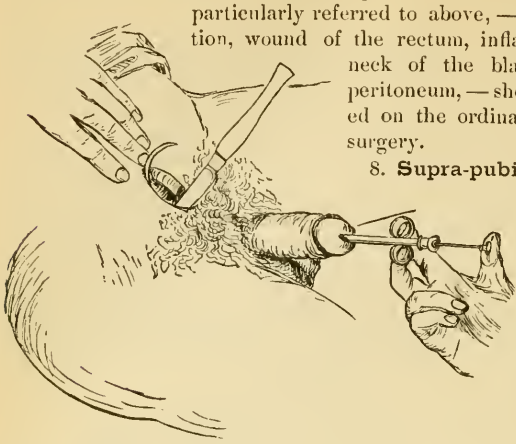


FIG. 528.

8. **Supra-pubic lithotomy** is performed only when the stone is very large, the patient not overfat, and the bladder capable of distention. Place the patient on a firm table with the pelvis slightly raised; fill the bladder slowly with water until it rises well above the pubes; make an incision in the median line, commencing at the symphysis, three or four inches, down to the linea alba; open this for about two inches upwards. Now pass the canula with the concealed trocar sonde-à-dard into the bladder, and protrude the trocar (Fig. 528); the bladder is now to be opened, the trocar being the guide; the hooked-gorget and spatula are now used to open the wound while the forceps are introduced (Fig. 529), and the stone seized and removed. The wound in the abdomen should be closed with sutures and no catheter or other instrument is required.

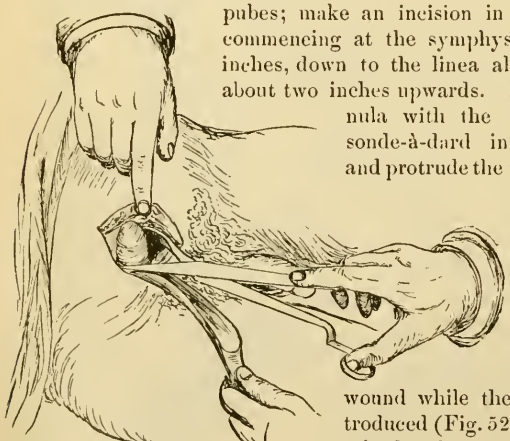


FIG. 529.

9. **Vesical calculus in women** may be removed by the following methods: (1.) Extraction through the dilated urethra may be effected if the stone is not of large size thus: give an anæsthetic;

place the patient in the lithotomy position, and with a dilator, consisting of two blades, or dressing forceps, introduced closed, distend the canal forcibly, until it is of the requisite calibre; seize the stone with strong forceps, and slowly withdraw it; in children, a stone of one inch, and, in adults, a stone of two inches in diameter may be removed by rapid dilatation.[1] (2.) If the stone is larger, crush it with the lithotrite, and remove the fragments with forceps and injections of warm water. (3.) If the former methods are not applicable, owing to the size of the stone, or the intolerance of the bladder, incision is required, as follows: (1.) The canal may be enlarged by incision made either upwards[2] or downwards or laterally.[3] (2.) The bladder may be opened through the vagina[4] by cutting from before backwards on a grooved director introduced through the urethra, and made to depress the vesico-vaginal septum; the wound must be immediately closed on the extraction of the stone, as in vesico-vaginal fistula. (3.) The suprapubic method may be practiced, when the stone is very large, in the same manner as in the male.

CHAPTER XLIX.

THE URETHRA.

THE urethra[5] is a tube of continuous mucous membrane, about eight and a half inches in length, supported by an outer layer of submucous tissue connecting it with the several parts through which it passes, and containing two layers of plain muscular fibres, the innermost being disposed longitudinally, and the outer circularly.

It is divided into three parts: (1) the prostatic, which passes through the upper part of the prostate gland, and is the widest part of the canal, being larger in the middle than at either end, and twelve to fifteen lines in length; though enclosed in firm glandular substance, it is more dilatable than any other part of the urethra; (2) the membranous portion which extends from the apex of the prostate to the bulb, being three quarters of an inch along its anterior, and half an inch on its posterior surface, owing to the projection upwards of the bulb; it is the narrowest division of the urethra; (3) the spongy portion, which includes the remainder of the canal, is about six inches in length, the bulbous portion being the largest; the succeeding portion of the canal is of uniform size to the glans, where it again expands, forming the fossa navicularis, which is from four to six lines in length, and terminates in the vertical fissure, meatus urinarius, two to three lines in extent.

[1] T. Bryant. [2] B. C. Brodie. [3] R. Liston. [4] J. M. Sims.
[5] Quain's Anatomy.

I. EXPLORATION.

1. **The urethra-meter**[1] (Fig. 530) is designed to gain a definite knowledge of the calibre of the urethral canal in cases with or without contraction of the meatus.

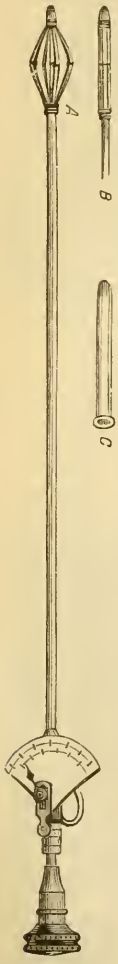


Fig. 530.[2]

It consists of a small, straight canula, size No. 8 F, terminating in a series of short metallic arms, B, hinged upon the canula and upon each other; at the distal extremity, where they unite, a fine rod running through the canula is inserted; this rod is worked by a stationary screw at the handle of the instrument, and when retracted, expands the arms into a bulb-like shape, A, ten millimeters in circumference when closed, and capable of expansion up to forty millimeters; a thin rubber stall, C, drawn over the end of the closed instrument, protects the urethra from injury, and prevents the access of the urethral secretions to the interior of the instrument. When introduced into the urethra and expanded up to a point which is recognized by the patient as filling it completely, and yet easily moving back and forth, the index at the handle then shows the normal circumference of the urethra under examination; in withdrawing the instrument, contractions at any point may be exactly measured, and any want of correspondence between the calibre of the canal and the external orifice be readily appreciated. Among the advantages claimed for this instrument are: (1) its capacity to measure the size of the urethra, and to ascertain the locality and capacity of any strictures, without reference to the size of the meatus; (2) it enables the surgeon to complete the examination of several strictures by a single introduction of the instrument, and by reduction of its size to avoid the irritation which usually attends the withdrawal of the ordinary bougie-à-boule or bulbous sound.

2. **The endoscope** is an instrument for the direct exploration of internal parts by the sight, as the interior of the bladder, urethra, rectum, uterus, nasal fossæ, pharynx, larynx, and even, in time, perhaps the œsophagus and stomach; it is, however, chiefly of use in diseases of the urethra.

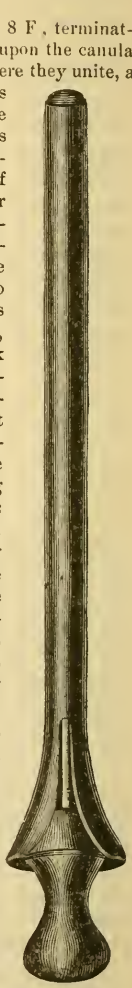


Fig. 531.[2]

It consists of a tube or speculum of hard rubber[1] (Fig. 531), which is introduced into the cavity to be examined; and at one extremity of this a mirror of polished silver, perforated in the centre, is placed at an angle of 45°, to reflect the

[1] F. N. Otis. [2] G. Tiemann & Co.

light, which is placed laterally, into the tube, so as to illuminate it to the end; as the calibre of the tube is very small, a most brilliant light is required, and, in order to obtain the best effects, it should be made to converge slightly upon the mirror, by interposing between the light and mirror a plano-convex lens of suitable focal length. The light being sufficient, the lens properly adjusted, the mirror bright and correctly placed with respect to the tube, the eye of the observer, looking through the perforation in the mirror, can see clearly to the bottom of the speculum. The meatoscope (Fig. 532) is for examination of the parts within an inch or more of the meatus.

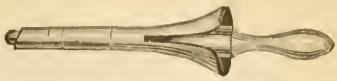


FIG. 532.[1]

3. **The circumference of the flaccid penis** generally bears a certain relation to the capacity of the urethral canal; by taking the measurement of the former the calibre of the latter can be very closely approximated before instruments are introduced.[2]

The following relations have been noted:[2] penis 3 inches, canal 30, of the French scale; penis 3½, canal 32; penis 3½, canal 34; penis, 3¾, canal 36; penis 4, canal 38; penis 4¼ to 4½, canal 40 or more. In every case the urethral calibre is over rather than under these figures.

4. **The catheter, sound, and bulbous bougie** are necessary to determine the condition of the urethra. One of the most convenient forms of catheter is the velvet-eyed (Fig. 533), which is yielding, and creates no irritation. The sound detects the presence of solid bodies, as calculi; the bulbous bougie measures the calibre and extent of strictures. An olive point may be fixed on the extremity of a stilet, in a spiral tube or catheter; the catheter is introduced with the bulbous extremity withdrawn, but when it is arrested the bulb is protruded through strictured points.

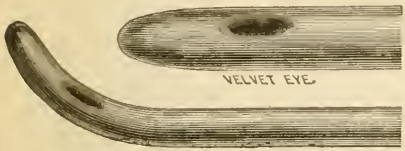


FIG. 533.[1]

II. DEFECTS.

1. **Imperforate urethra**[3] may consist of a closed meatus, which must be opened by puncture or incision; or of a diaphragm lower down, which must be perforated by a trocar. If the tube is deficient throughout, the bladder must be opened by perineal section, and an effort must be made to construct a permanent passage.

2. **Hypospadias**[4] is the result of deficiency of the lower wall of the urethra, and may occur at any part of the penis; in the scrotal form the orifice is often abnormally large, and the parts resemble

[1] G. Tiemann & Co. [2] F. N. Otis. [3] Sir H. Thompson. [4] T. Holmes.

those of the female (Fig. 534); the most frequent location of the orifice is just behind the glans, but the most serious defects are posterior to this point. In some cases there is a shortening or retraction of the corpus spongiosum and fibrous envelopes of the corpora cavernosa, causing incurvation of the penis, especially during erection. Treatment of hypospadias is advisable only when it appears to be inconsistent with the power of impregnation, or when the opening is so small as to afford a real obstacle to the passage of the secretions.

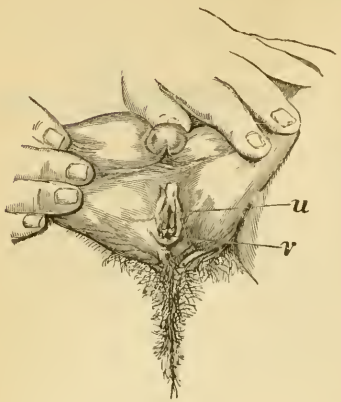


FIG. 534.

When the defect is in the balanic portion, the following operation [1] will prove most satisfactory (Fig. 535): Make longitudinal incisions 2, 3, sufficiently far apart to leave ample material for the new urethra, and 4, 5, one quarter of an inch outside; dissect the integuments from the spaces bounded by these incisions; preserve intact the mucous membrane and skin in all the central space included between the incisions 2, 3, and 1, 10; slide the loose skin at the root of the penis and of the scrotum gradually forward, making it double upon itself until 3, 3, is brought to 2, 2, and the denuded surfaces are brought into accurate apposition, making the angle of the fold at 7, 7; take the first suture at 6, 6, passing the upper from within outwards and the lower from without inwards; before tying the suture of one side, pass that of the opposite side, tie and cut the ends short, leaving the knot inside of the newly formed urethra; apply sutures along the external side at 3, 5, 9, and 2, 4, 8. The meatus becomes transverse, its inferior lip being the fold of skin from 10, formed by the apposition of the points 3, 3 to 2, 2, and its superior lip the edges of mucous membrane 2, 2.

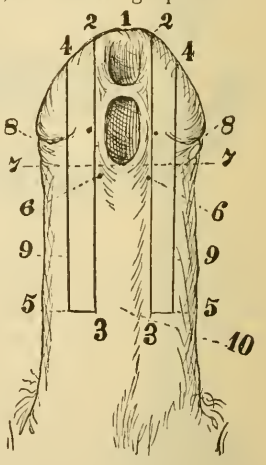


FIG. 535.

[1] J. W. S. GOULEY.

When the opening is behind the glans, and the organ is otherwise well formed, no operation is required, or at least only a freshening of the edges and their union by suture; if the opening is in the penile portion, and the organ is incurved, the latter must first be relieved by subcutaneous section of the tense fibrous structures, while the organ is forcibly extended; slight transverse incisions of the skin may be required, and when the penis is extended these incisions will become longitudinal, and may be united by suture in this form.[1]

When the opening is in the penile portion, several operations have been successfully practiced, and are worthy of trial.

(1.) Make an incision on the left side, from the glans to the scrotum (Fig. 536), through the skin, half an inch from the median line and parallel to it; from each end of this incision make oblique incisions to the median line, and dissect up the flap thus formed; make a second longitudinal incision to the right of the median line, but near it, of the same length, and lateral incisions from each extremity an inch and a half, and raise the flap; introduce the sound, and turn the first flap backwards over it, the epidermic surface towards the urethra, and insert sutures in the margin; put each of the ends through the eye of a needle, which must be passed from within outwards through the base of the other flap (Fig. 537), and fastened by shot compressed upon it; the right flap is placed upon the raw surface of the first, and fastened to the margin of the first incision; the catheter is to be removed, but should be introduced to remove the water.[2]

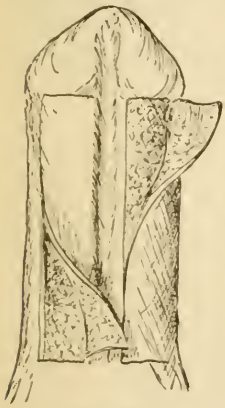


FIG. 536.

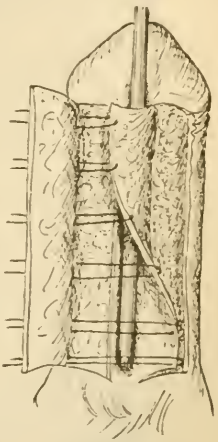


FIG. 537.

(2.) The meatus is first restored by paring the two lips of the notch which represent it, and the pared edges are united over the end of a probe introduced; then two longitudinal incisions are made from the glans nearly to the false opening on either side of the median line, and at a distance from it equal to half the circumference of the new urethra; at the extremities, transverse incisions are made nearly to the median line; these flaps are dissected from without inwards, and raised towards the median line so as to completely cover a sound of convenient size previously introduced through the newly-formed meatus; next, the skin at the sides is dissected up and drawn towards the middle line to cover

[1] Bouisson. [2] T. Anger.

the denuded surface; the two layers of skin are united in the middle line, and the upper margin of each flap to the lower margin of the glans, after paring; the scrotal fistula is pared and united to the newly-formed canal.[1]

FIG. 538.

(3.) Make an incision near the edge of the fistula and extending beyond it three eighths to one half an inch at each end, 1, 1 (Fig 538), and dissect up a flap bounded by the dotted curved line. Make a curved incision on the opposite side, and extending nearly to the points of the first incision, and broad enough to include a flap of sufficient width to cover the fistula and reach the dotted curved line when turned on itself; scrape the outer surface of this flap to remove the epidermis, and dissect it up to the edge of the fistula; pass each end of a thread through a fine curved needle; pass these two needles about one quarter to one sixth of an inch apart through the edge of the curved flap from the epidermic surface, and then from within outwards on the dotted line border of the flap formed by the straight incision; after passing a sufficient number of these sutures, one to every one half or three fourths of an inch (Fig. 539), draw the curved flap under the straight one, into the space formed by dissecting up the latter, so that its edge will correspond to the dotted curved line, and secure them over a piece of cork; then pass sutures across the uncovered space; uniting the edge of the straight flap with the skin on the edge of the curved incision (Fig. 540), and secure them.[2]

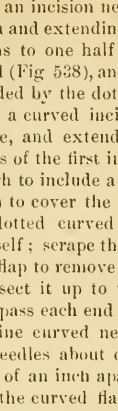


FIG. 539.

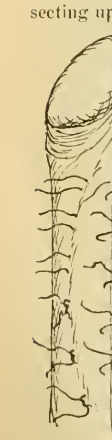


FIG. 540.

3. **Epispadias**, defect in the upper wall of the urethra, is frequently attended with other deficiencies of the neighboring parts; it may be a slight fissure, or may extend from the glans nearly to the bladder; operations for its relief have generally failed. The following method deserves trial: —

The operation[3] requires several sittings. To make the meatus and parts belonging to the glans, two incisions are required, one on each side of the groove; the surface of the outer lip of each incision is pared, and the fresh surfaces are united with the twisted sutures. To make the urethra, an incision is required along the groove on the right side, and transverse incisions at its two extremities. On the left side, a similar incision is made but three fourths of an inch from the groove; this flap is dissected up and turned over to form a roof for the new urethra, its cutaneous surface being turned downwards; liga-

[1] S. Duplay. [2] Szymanowski. [3] Thiersch.

tures are passed near its free border and then through the base of the other flap, which is drawn over the first so as to bring their raw surfaces together; the anterior space between the new urethra of the glans and of the body is closed by making a transverse incision through the prepuce, passing the glans through it, and paring the borders and attaching them to the edges of the incision of the prepuce; the posterior portion of the canal is closed by flaps from either groin, in the same manner as the urethra, one being reflected to form the urethra, the other to cover the first flap; the edges of the old flaps being refreshened.

III. INJURIES.

1. **Simple incised wounds**[1] are dangerous in proportion to their depth, as regards their direction and the tissues involved. The indications are, to prevent extravasation of urine by enlargement of the wound if necessary, or the introduction of a catheter.

2. **Contused and lacerated wounds** generally result from falls astride of hard bodies, and are more frequently located in that portion related to the deep perineal fascia, and it is in this part that there is the greatest risk to life, owing to the tendency to urinary infiltration, and the liability to intrapelvic suppuration and peritonitis.[1] The rupture is usually due to the forcible pressure of the urethra against the triangular ligament.[2] The tube may be torn partially or completely across. The symptoms may be very slight, but generally there are contusions, inability to pass water, and bleeding from the urethra. At first, an effort should be made to pass a flexible catheter, but the utmost gentleness must be used, in order not to engage the point in the rent; if the rent is longitudinal, the catheter may pass without much difficulty;[3] if it is transverse, and involves only the lower portion, the extremity of the catheter may be passed along the roof; in some cases the stilette may be carried in the flexible bougie, and when the obstruction is met with by withdrawing the stilette an inch the end of the catheter is suddenly raised and passes the obstruction. The catheter should rarely be retained owing to the liability to extravasation by its side.[1] If there is hæmorrhage, ice must be applied. If the catheter cannot be passed, or there is a distinct hard tumor at the seat of injury, perineal section must be at once performed to give free escape to the urine: pass a sound down to the rupture, and make the incision down to its extremity.

Delay in the performance of this operation causes imminent risk, and probably an aggravation of the local mischief.[1] These lesions always render the patient liable to subsequent strictures, often of an intractable kind, and hence the importance of restoring and maintaining the full capacity of the canal in the subsequent treatment.

3. **Laceration of the mucous membrane** of the healthy urethra more often results from forced catheterism; the catheter is usually

[1] J. Birkett. [2] J. W. S. Gouley. [3] S. Rogers.

arrested at the triangular ligament, and if force is used the mucous membrane yields and a false passage results.[1] In the strictured urethra, lacerations occur from attempts to force a passage; the point of the catheter passes on the side where pressure is greatest. These lacerations may lead to infiltration, and then incisions are required, especially when the wound is in the perineal portion; ordinarily, the false passage becomes a part of the treatment of stricture.

IV. FOREIGN BODIES.

1. **Substances introduced** into the urethra from without include every variety of material, as pins, pencils, stones, beads; they tend to advance into the bladder, but, if arrested, they cause retention, and finally ulceration. Immediate removal is necessary. The most useful instrument is forceps with a long handle which separate only at the blades (Fig. 541); for bodies in the anterior part of the

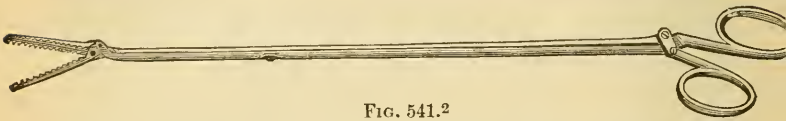


Fig. 541.[2]

urethra, slender forceps, with suitable blades are necessary (Fig. 542);[3] pressure must be made behind the body, if possible, to prevent its being forced backward by the forceps.

If the body be long and soft, as a catheter or piece of wood, it may be transfixed with a stout needle through the floor of the urethra and the canal pushed back over it, like a glove over a finger, as far as possible, when it may be transfixed again, and so urged forward until it can be seized at the meatus.[4] If the body cannot be dislodged it must be removed by a longitudinal incision.

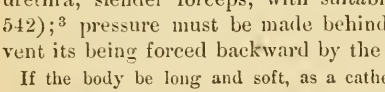


Fig. 542.[2]

2. **Calculus** may lodge in the urethra in its passage from the bladder; or an angular fragment of a crushed stone. The points where it is most liable to lodge are, (1) the membranous portion, at the triangular ligament; (2) in the middle of the penile portion; (3) at the meatus. If the calculus is posterior to the triangular ligament, push it back into the bladder with a large catheter; if it is immovable without great force, which must be avoided, it may be forced back by injections through the catheter, of warm water, olive oil, or flaxseed tea. If the body is anterior to the ligament, it should be withdrawn through the meatus by means of the forceps mentioned; if this effort fails, the three-blade searcher,[5] or trilabe (Fig. 543),[6]

[1] J. W. S. Gouley. [2] G. Tiemann & Co. [3] Sir H. Thompson.
[4] Van Buren and Keyes. [5] J. Hunter. [6] Civiale.

should be employed. Introduce the blades withdrawn into the handle, until the calculus is reached; then carefully open the blades, and

Fig. 543 [1]

when expanded gently insinuate them beyond the stone; now close the blades, and withdraw. Other methods are the various forms of scoops (Figs. 544, 545, 549).

Fig. 544.[1]

The scoop may consist of a female and male blade; the former may be movable, or it may be fixed. The first should be introduced with the scoop straight and the male blade withdrawn (Fig. 545); the

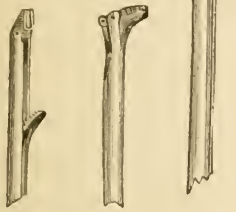


Fig. 545. Fig. 546. Fig. 547.

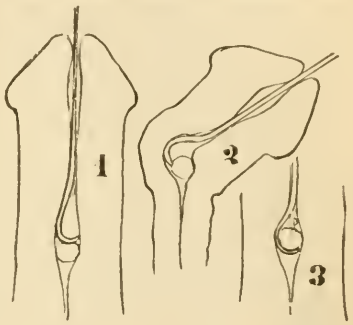


Fig. 548.

scoop must be insinuated by the side of the stone until it passes behind, and then brought to a right angle (Fig. 546); the male blade should then be forced

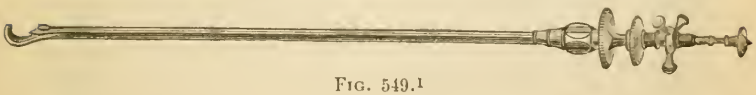


Fig. 549.[1]

down by means of the screw (Fig. 547), when the stone is caught, and removed or crushed. If the scoop is fixed (Fig. 549), it must be hooked over the calculus.[2] Pass the scoop down to the stone, compressing the penis behind it, 1 (Fig. 548); bend the penis at a right angle, and crowd the point of the scoop along the wall of the urethra, 2, until its point passes around the stone, 3; now turn the screw, force the stylet down upon the stone (Fig. 550), and withdraw it. If the stone cannot be removed by these means, longitudinal incision must be made in the median line.

Fig. 550.

[1] G. Tiemann & Co. [2] Rilequet.

V. STRICTURE.

Stricture is an abnormal contraction of some portion of the urethral canal, which may be transient, from spasm or congestion, and permanent or organic, from deposit in or around the walls of the urethra.[1]

In the correct sense, there can be only the permanent or organic stricture; spasm of the urethra is doubtless of very frequent occurrence, but does not, properly speaking, constitute stricture; in permanent stricture there is often a very decided tendency to spasm, and inflammatory swelling, sufficient to cause retention of urine, not unfrequently occurs in an already constricted canal, but these conditions do not come within the definition.[2]

1. **Spasmodic stricture** may be caused by a local lesion, as partial organic stricture, or by excitement existing elsewhere, as inflamed hæmorrhoids.[1] Contraction of the meatus and slight organic stricture of the anterior portions of the urethra will cause spasmodic stricture of the deeper parts closely resembling deep organic stricture.[3] The distinguishing feature of this form of stricture is its transient character, and the return of the urethra to its natural degree of patency.[1] The treatment consists in relieving the bladder by a hot bath, rest, and opiates, or at once by an anæsthetic and catheter; the removal of the cause must follow, as the correction of vicious habits, the gouty diathesis, or concentrated urine;[4] the contracted meatus must be enlarged, and the slight stricture dilated.[3]

2. **Permanent stricture** results from organic deposit in or around the walls of the urethra, due to inflammation following injuries, or irritants of the mucous membrane. It may vary in the degree of constriction from a slight diminution of the calibre of the urethra, stricture of large calibre,[3] to the almost complete closure of the tube. In ordinary cases, the following forms are recognized, namely, (1) the linear, (2) annular, (3) tortuous. Stricture may occur at any point in the urethra, but in searching for it the natural narrowing of the passage must be remembered.

The locality of organic stricture is variously given. The examination of 270 museum specimens proves that the order of frequency of strictures is as follows: (1) At the junction of the spongy and membranous portion, and an inch before and three fourths of an inch behind that point, 67 per cent.; (2) the spongy portion, to within two inches and a half of the external meatus, 16 per cent.; (3) within two inches and a half of the meatus, 17 per cent.[1] Measurements by the urethra-meter, in 258 living subjects, give very different results, as follows: in the first quarter inch, 52; in the following inch, 63; next inch, 48; next inch, 48; next inch, 19; next inch, 14; next inch, 8; next inch, 6.[3]

The symptoms of stricture depend upon its stage. A chronic

[1] Sir H. Thompson. [2] J. W. S. Gouley. [3] F. N. Otis.
[4] Van Buren and Keyes.

urethral discharge is an invariable sign of stricture,[1] and should always lead to an examination with suitable instruments; [2] pain is usually felt in the urethra behind the stricture at the time of micturition; urination is increased in frequency, and the stream is altered in form, becoming more or less flattened, perhaps twisted, spirting, forked, or even divided; as contraction increases the stream grows smaller, the force of the current is lost, the act of micturition is more frequent and prolonged; in the worst cases there are almost constant efforts to obtain relief by change of posture and straining, with tenesmus of the rectum and protrusion of the mucous membrane; finally, retention becomes more and more frequent, with the incontinence due to a distended bladder.[3] These symptoms are not sufficient alone to establish the presence of stricture, and it is necessary to explore the urethra; with an instrument, its existence may be ascertained, its location and calibre, and whether more than one is present.[3] It is, however, always necessary, in the detection of slight contractions to know the normal calibre of the urethra in each particular case, for every urethra has a distinct individuality, irrespective of standards, or even of general physical proportions.[1]

It is a very common error to suppose that when a No. 10 or 12 instrument is passed a patient has no stricture, for one adult may have a perfectly healthy urethra so small as to admit only a No. 8 or 9 sound, while another man's urethra may admit No. 16 17, or 18 and be constricted; it is necessary, therefore, to be governed by the normal calibre in each individual case.[4]

Complete freedom from stricture can only be demonstrated by the easy passage of a bulbous sound of a size fully equal to the normal calibre of the presenting urethra; this calibre should first be accurately determined by the urethra-meter, or by the less accurate method of measuring the circumference of the flaccid penis.[1]

Fig. 551.[6]

The simplest, and best of all the explorers now in use, is the bulbous bougie (Fig. 551), of various sizes [5] which, owing to the flexibility, accommodates itself to the curves of the urethra, and yields to the slightest obstruction, qualities which render it infinitely more delicate than metallic instruments.[4] An instrument of wider range and greater endurance is the bulbous sound (Fig. 552), which consists of a metallic bulb of olive shape, attached to a slender copper shaft; for convenience the bulbs may screw upon a common handle.[1]

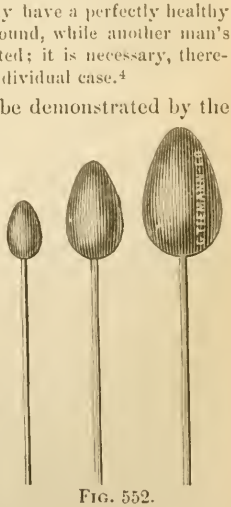


Fig. 552.

[1] F. N. Otis. [2] H. Dick. [3] Sir H. Thompson. [4] J. W. S. Gouley.
[5] Leroy d'Etiolles. [6] Codman & Shurtleff.

Before commencing the direct exploration of the urethra, it is desirable to see the patient urinate, in order to ascertain the size and form of the stream; the glans should then be examined, and the position and size of the meatus ascertained.[1]

Contractions of the meatus are a fruitful source of failure to appreciate abnormal narrowings of the urethra; the complete suppleness and resiliency of the tissues of the normal meatus is a good test of its freedom from organic stricture, but congenital contractions to a greater or less extent are not infrequent; hence both the natural suppleness and resiliency may be present, and the deformity may escape notice, unless carefully sought.[2]

As a rule, whenever a bulbous sound can, by gentle pressure three or four minutes, be made to slip into the fossæ navicularis, and in the withdrawal is abruptly arrested, the indication for the free division of the meatus is positive, for without it no efficient exploration of the deeper parts can be effected.[2] The meatus must be enlarged by an incision on the inferior wall of the canal with a bulb-pointed bistoury, and to an extent which will allow the passage of the bulbous sound with the utmost freedom.[2] Now, introduce a well-oiled instrument, as large as the orifice will admit, and pass it slowly along the canal till it meets an obstacle which presents a positive hindrance to its progress (Fig. 553); mark the stem of the bougie with the nail, and withdraw and measure to ascertain the location of the stricture, select a smaller instrument and pass it beyond the obstacle (Fig. 554); on withdrawing the bulb the base will present at the vesical extremity of the stricture; if the measurement is repeated and the difference is added to the length of the smaller bulb, the length of the stricture will remain; these bougies aid in ascertaining the form, diameter, and number of strictures, the tender spots in the urethra, and the presence of pus.[1]

FIG. 553.

FIG. 554.

Stricture should be cured at every stage, for if the balance between the natural expulsive force of the bladder and the friction of the stream along the urethra are disturbed, the bladder is irritated, the kidneys are affected, and the beginning of the long chain of events, which terminate not infrequently in death, is made.[3] Treatment is directed (1) to restore the natural calibre of the canal, and (2) to maintain its adequate patency; as strictures vary in amount of contraction, in dilatibility, in disposition to return, in local sensibility, and in liability to manifest sympathy with other parts of the body, various modes of treatment are necessary and appropriate to different cases.[4] These different methods will be appreciated in connection with special degrees and conditions of stricture.

[1] J. W. S. Gouley. [2] F. N. Otis. [3] B. Hill. [4] Sir H. Thompson.

Strictures at or near the meatus[1] should be treated by division on the inferior wall of the canal, with a straight bulb-pointed bistoury; the utmost freedom to the passage of the bulbous sound must be obtained, and not a single trace of contraction left uncut. Means must be used to prevent inflammation, as rest, and cold water applications. Strictures of large calibre, or incipient strictures, in the pendulous urethra, must be treated by a process of divulsion and urethrotomy which results in a complete rupture or division of every fibre of the contraction; no one instrument can ever be depended on to succeed completely in all cases; in ordinary stricture the dilating urethrotome is more easy of management.

It consists of a dilating apparatus which, when closed, is equal to about twenty of the French scale; upon its superior aspect a blade, guarded at the top, is slid down through a groove to the end of the shaft; the screw at the handle is then slowly turned until the handle on the dial indicates that the instrument is dilated up to two or three millimeters beyond the previously ascertained normal calibre of the canal; the blade is then slowly withdrawn, cutting through all the stricture on the superior wall of the urethra; the instrument is now withdrawn and a full sized bulb passed; if any fibres of the stricture remain, the operation must be repeated at the contracted point until perfect freedom is secured.

Cold should be applied as before, and sounds may be passed to separate the cut surfaces, not to cause dilatation, but their use must be discontinued as soon as a full-sized bulb can be passed through and beyond the previous site of the stricture and withdrawn without a trace of blood.[1]

Recontraction of stricture, after operation, is due to incomplete division, and this will, as a rule, be detected within one week, or, at most, two weeks, by which time the stricture tissue distended, and not divided, will sufficiently recontract to become readily recognizable by the full-sized bulb.[1]

Strictures of a calibre of less than 16 or 18 of the French scale, or 7 or 9 of the English, require enlargement by gradual dilatation with soft bougies, when they are well borne, but if not, by divulsion; after having been brought up to a capacity permitting the passage of the dilating urethrotome, complete division of the stricture should be effected by means of that instrument.[1]

Dilatation is the mildest and most desirable treatment, being generally applicable, and best adapted to a very large proportion of cases; in ordinary cases a flexible bougie, as large as the stricture will easily admit, should be passed fairly through it, and then at once withdrawn with gentleness; in two or three days it is repeated, and if the bougie passes with ease, one of larger size must be introduced; gradual advance must then be made until 12 or 13 can be passed.[2] But dilatation, temporary or persistent, is never more than a palliative measure, unless carried to a point sufficient to completely rupture the stricture.[1]

To treat a stricture by divulsion is to make a longitudinal rent of the constricted portion of the urethra; this may be accomplished by the successive in-

[1] F. N. Otis. [2] Sir H. Thompson.

troduction of conical sounds, of different sizes, which act on the principle of a wedge, or by any of the various divulsors.[1] There are three instruments well suited for the treatment of stricture by this method,[2] namely, (1) The first[3] consists of two parallel blades, slightly curved towards the beak at which they are joined; the blades may be separated laterally to the desired extent by turning the handle; the shaft is marked by lines one inch apart to indicate the depth to which it penetrates. This instrument, as modified, by reducing the size of the shaft and tunneling the beak (Fig. 555), so that it may be introduced through small strictures, is to be preferred.[1] In using this instrument the depth of the stricture must first be accurately determined by the bulbous bougie; the metallic slide is then pushed down upon the

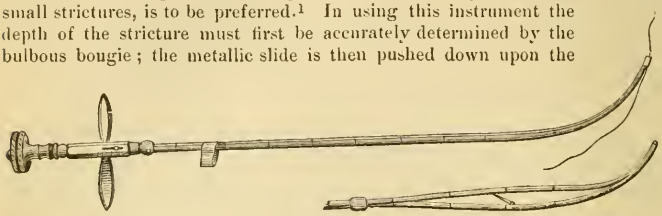


Fig. 555.[4]

closed instrument until its point of greatest dilatability equals the distance from the meatus to the centre of the stricture; no anæsthetic is required; pass the instrument into the urethra until the meatus is touched by the slide, and the greatest dilatibility corresponds to the centre of the stricture; now turn the handle rapidly until the blades have been separated to an extent several sizes larger than the patient's meatus will admit; the failure of the operation is due to the employment of too little force; it is better to tear too much than too little, as it is only the stricture which yields; the flow of blood is evidence of rupture.[2] (2.) The second form of divulsor[5] consists of two grooved blades fixed in a divided handle (Fig. 556), containing a wire welded to their points; on this wire a

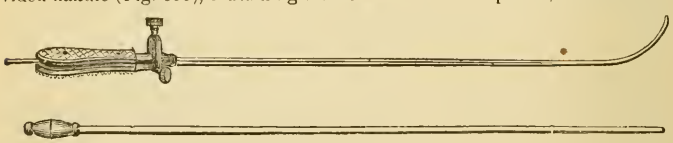


Fig. 556.[4]

tube corresponding to the natural calibre of the urethra is quickly passed and ruptures or splits the obstruction; the instrument should first be passed into the bladder, when a few drops of water will escape, then place the tube selected on the wire and thrust it quickly onwards to the end, now rotate the shaft and withdraw it, and substitute a catheter of equal size. (3.) The third form[6] resembles the second in having two parallel blades, but they act by fitting into grooves of solid conical and cylindrical shafts; the blades are first introduced closed, and then the shaft selected is fitted into the grooves and driven forcibly home, separating the blades laterally.

The defect in these instruments is their want of adaptability to the dimensions of the stricture upon which operation is required; the amount of resiliency of the stricture in the flaccid urethra is undetermined, and hence the divulsing shaft is selected without exact data, and the size of the blade in the cutting in-

[1] J. W. S. Gouley. [2] Van Buren and Keyes. [3] Sir H. Thompson.
[4] G. Tiemann & Co. [5] B. Holt. [6] Voillemiers.

strument being left to conjecture is liable to be unsuited to the case.[1] There is, therefore, need of an instrument which will supplement the other divulsor and prove reliable in the complete division of the stricture and the enlargement of the calibre of the urethra to its full normal capacity. This is found in the following dilating urethrotome (Fig. 557):[1] A pair of steel shafts, *A*, *B*, are connected by short pivotal bars; the expansion and contraction are effected by means of a screw in the handle, connected with the lower shaft, and moved by a finger button, *C*; short curved registering arms, at *D*, mark the divisions of the American and French scale; a scale of inches and quarter inches are marked on the shaft, *B*, by which its depth in the urethral canal is rated; the upper bar of the instrument is hollowed out, and traversed by a urethrotome; by the metallic handle, *G*, of the urethrotome, it is moved at will through the entire length of the shaft, *A*; a small button, *H*, secures the canula at any point; running through the canula, and attached to the handle, *I*, is the staff of the urethrotome, which, when at the extremity of the canula, is concealed in the deep groove; on withdrawing the handle, *I*, the canula being firmly fixed at any given point by the button-screw, *H*, the spring blade, *J*, rises out of the groove by means of a little elevation on its floor, rides over it, displaying the full width of its blade for half an inch, then drops into the groove and is concealed. The instrument is used as follows: Introduce it with the urethrotome beyond the known point of stricture. Now dilate the shafts, *A*, *B*, until the stricture is made tense; turn the button-screw, *H*, releasing the canula, which must be drawn outwards until the knob of the urethrotome, beyond *J*, is arrested; the canula is then advanced half an inch, and fixed, and then by a rapid movement outward of the handle of the urethrotome the blade is brought up through the stricture from behind forwards; the finger-button, *C*, is again turned and the shafts separated, to determine whether the stricture is completely divided; if not, the knife may be passed from before backwards.

Fig. 557.[2]

There is a class of small strictures with tortuous or false passages which require the use of filiform bougies, as guides to other sounds; these guides are made of whalebone, of various sizes down to that of a horse-hair; they are ordinarily twelve inches long, with straight, angular, and spiral points (Fig. 558). They are used as follows:[3] Inject oil into the urethra; then introduce the bougie, straight or bent, along the floor of the canal to avoid the lacuna magna; if it enter a lacuna, withdraw, and change the direction; in exploring for the entrance of a stricture, a slight to-and-fro motion should be

Fig. 558.[2]

[1] F. N. Otis. [2] G. Tiemann & Co. [3] J. W. S. Gouley.

given; if the effort fail with one form, another must be substituted, and the whole calibre of the urethra must be examined; if the sound has passed the stricture, it will be movable back and forth; if it enter a false passage, allow it to remain, and pass others by its side until one passes on into the bladder. Having reached the bladder, the bougie serves as a conductor upon which the tunneled sound (Fig. 559), may pass, and both dilate and straighten the stricture.[1]

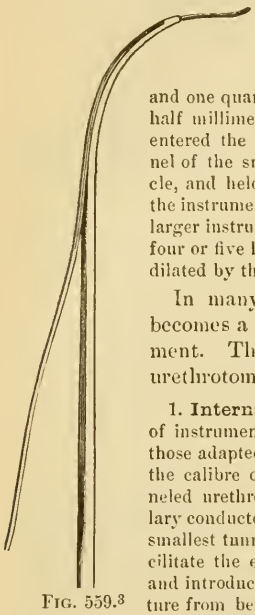


Fig. 559.[3]

The tunneled sound[1] is a grooved, conical steel sound with a canal one eighth of an inch in length at the vesical extremity, and with a curve equal to one fifth the circumference of a circle three and one quarter inches in diameter; the smallest is one and a half millimeters in diameter at the point; when the guide has entered the bladder, the free end is slipped through the tunnel of the smallest sound, which is carried down to the obstacle, and held in firm contact with it for a few moments, when the instrument will pass, but no undue pressure should be used; larger instruments should be passed at the same sitting, up to four or five higher numbers.[1] The stricture may now be fully dilated by the dilating urethrotome.[2]

In many obstinate cases, incision of the stricture becomes a necessary and important part of the treatment. This incision may be (1) internal, internal urethrotomy, or (2) external, perineal urethrotomy.

1. **Internal urethrotomy** is performed with a great variety of instruments, but they may be usefully classified into, (1) those adapted to the smallest stricture, and (2) to strictures of the calibre of Nos. 4, 5, or 6. For the former, use the tunneled urethrotome (Fig. 560),[1] as follows:[1] Pass the capillary conductor into the bladder; slip the distal end through the smallest tunneled sound, and dilate the stricture a little to facilitate the entrance of the urethrotome; remove the sound, and introduce the tunneled urethrotome, and divide the stricture from before backwards by sliding the instrument gently upon the conductor until all resistance to its passage ceases; withdraw the urethrotome, leaving the conductor in position; now pass a large tunneled or other

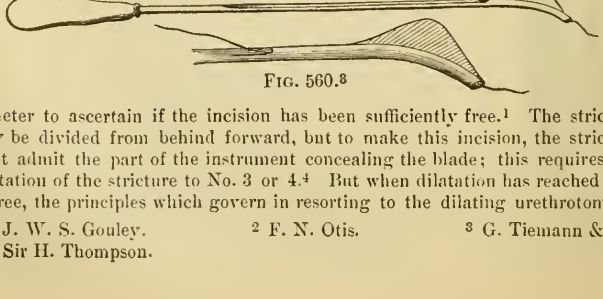


Fig. 560.[3]

catheter to ascertain if the incision has been sufficiently free.[1] The stricture may be divided from behind forward, but to make this incision, the stricture must admit the part of the instrument concealing the blade; this requires the dilatation of the stricture to No. 3 or 4.[4] But when dilatation has reached that degree, the principles which govern in resorting to the dilating urethrotome in

[1] J. W. S. Gouley. [2] F. N. Otis. [3] G. Tiemann & Co.
[4] Sir H. Thompson.

FIG. 561.[3]

strictures of large calibre should be applied to these strictures of small calibre.[1] The instrument for this operation combines dilatation with incision (Fig. 561);[2] its application is apparent.

2. **External or perineal urethrotomy** is required when dilatation is unsuccessful, or impracticable, or there are fistulous passages. In some cases it may be possible to pass a grooved staff through the stricture, which greatly simplifies the operation; in other cases the stricture is so tight as to admit only a filiform bougie, which is an important guide, but a certain number are altogether impassable, and the section must be made without a guide. For several days before the operation, when there is no urgency, it is well to direct the patient to assume the recumbent position and take a hip bath every night, also, ten drops of tr. ferri chloridi three times daily, and five grains of quinine at bed-time, with a suppository of one grain of opium and half a grain of the extract of belladonna every night; the bowels must be moved by oil and an enema before the operation.[1] Operate as follows: After filling the urethra with olive oil, introduce a capillary probe-pointed whalebone bougie into the urethra; if its point enter a false passage, pass others by its side until one enters the bladder; upon this guide pass a tunneled groove staff into the bladder; by the rectum explore the membranous and prostatic divisions of the urethra; now make a free incision in the median line of the perineum, extending from the base of the scrotum to within half an inch of the anus, involving skin and superficial fascia; continue the dissection until the urethra is brought into view; open the canal upon the groove of the staff, pass a thread of silk through each edge of the incised urethra with which the wound may be kept open by an assistant; with a beaked, narrow, straight bistoury, passed along the guide, divide the stricture and half an inch of the uncontracted canal behind it; now pass the catheter, guided by the whalebone bougie, into the bladder; if it is obstructed, extend the incision. The after treatment should be ten grains of quinine and one fourth of a grain of morphia immediately to prevent fever; three grains of quinine, daily, with iron, for two or three weeks, and warm hip baths; on the second day a full-sized conical steel sound is passed, and repeated every third day until the wound is healed.

If the stricture is impassable, pass a large sound until it rests upon the face of the stricture; an assistant holds it firmly and draws the scrotum upwards; the dissection is the same as the preceding, until the sound is exposed; insert threads into either margin of the urethra with which to keep the wound open; with small grooved directors, search for the contracted passage, and, if found, pass the

[1] J. W. S. Gouley. [2] F. N. Otis. [3] Geo. Tiemann & Co.

director as far as possible and enlarge it by incision; continue this method of dissection until the passage is complete; if the director cannot be introduced, make the dissection accurately in the line of the canal; as soon as the continuity is restored, introduce a full-sized sound; repeat the passage of the sound, as before, but do not allow it to be retained.

3. **Tapping the urethra at the apex of the prostate** by perineal incision [1] is a rapid method of relieving the distended bladder in impassable stricture, as follows: Place the patient in the lithotomy position; introduce the left forefinger into the rectum and place its tip on the apex of the prostate; plunge a double-edged knife into the median line of the perineum and carry its point forward towards the tip of the finger, enlarging the external wound by an upward and downward movement; when the point is felt near the finger's end, it is made to open the urethra by a slight movement to the right or left; now withdraw the knife and introduce a probe or director into the urethra and thence into the bladder; withdraw the finger from the rectum, and, holding the director with the left hand, pass a large catheter into the bladder. This new opening may be made permanent; [1] or the stricture may be cut through in front, a catheter passed, and a new urethra established.[2]

VI. THE FEMALE URETHRA.

1. **Catheterism** of the female urethra is effected as follows: the patient lying on the back, completely covered, with the knees flexed, stand, if convenient, upon the right side; holding the short catheter, well oiled, between the thumb and second finger of the right hand, the point resting near the tip of the index finger, pass the hand under the thigh, carry the index finger between the labia to the entrance of the vagina, where the meatus will be detected as a slight elevation with a central depression; as the tip of the finger rests on the posterior edge, glide the catheter forwards and into the meatus with the thumb and second finger.

Or, the gum elastic catheter may be used, which must be introduced with the left hand carried above the thigh, after the right index finger has detected the meatus. This simple operation may prove very difficult and embarassing, and exposure of the parts may be necessary for its completion.

2. **Stricture** may occur from injury, gonorrhœa, or chancre, and is usually located near the meatus. It must be treated by dilatation, and, if necessary, add incision.

3. **Prolapsus urethræ** [3] consists of prolapse of the urethral mucous membrane; it is not frequent, but causes considerable irritation of the urethra and bladder, and is often mistaken for irritable caruncle. It appears as a red projection encircling the meatus, more or less sensitive, and liable to bleed; it may exist for a time without symptoms, but finally causes painful micturition, leucorrhœa, and local irritation. Seize the prolapsed circle with tooth-forceps, and cut it off with curved scissors. Or, include the mass in ligatures; or, use the galvano-cautery with wire.

[1] E. Cock. [2] C. J. Guthrie. [3] T. G. Thomas.

X.

THE GENERATIVE ORGANS.

THE MALE ORGANS.

CHAPTER L.

THE TESTICLES.

The testicles are two glandular bodies which secrete the spermatic liquid, and are suspended within the scrotum, one on each side by the spermatic cords.[1]

I. THE SCROTUM.

The scrotum is the pendent pouch below the pubes containing the testicles; the skin is thin, darker than elsewhere, more or less wrinkled, and marked in the median line by a slight ridge, the raphé; the inner portion of the skin is composed of pale and unstriated muscular fibres, the dartos.[1]

1. **Contusions of the scrotum**[2] are chiefly remarkable for the large quantity of blood liable to be effused beneath the skin. When the contusion is severe, and the extravasation considerable, inflammation sometimes arises and even terminates in suppuration. All the treatment required, if the testicles have escaped injury, is rest, support with a bandage or pillow, and a lotion of muriate of ammonia, or a poultice of oatmeal and vinegar.

2. **Lacerations of the scrotum**[2] though formidable in appearance, usually terminate favorably; there is no hæmorrhage, but, owing to the contractile nature of the integuments, the wound gapes and the testicles protrude. Cleanse the wound with carbolized water, remove coagula, return the testicles, and close the wound with sutures and adhesive plaster; protect the parts from urine by oiled silk, secure rest, and the application of cold.

3. **Diffuse inflammation of the scrotum**[2] occurs in two forms. (1.) The mild form begins as a light erythema and terminates favor-

[1] J. Leidy. [2] T. B. Curling.

ably under gentle antiphlogistic treatment. (2.) The more severe form runs a rapid and dangerous course and tends quickly to mortification, with typhoid symptoms; it attacks persons of a cachetic habit and broken down constitution. The treatment is prompt incisions into the distended connective tissue to relieve tension; hæmorrhage must be prevented by filling the wounds with dry lint; carbolized water dressings should then be applied, or light poultices. The general treatment must be actively tonic and stimulating.

4. **Mortification of the scrotum**[1] is the result of the preceding inflammation or of urinary extravasation. This sloughing is not free from danger, but in general the extension of gangrene may be arrested by yeast poultices, and thorough cleansing of the parts with carbolic solution, combined with tonics. Fortunately there is no part of the body in which the reparative efforts are more remarkable after extensive mortification; even when the whole scrotum and part of the integument of the penis have sloughed away, granulations have rapidly sprung up from the exterior of the tunica vaginalis and investments of the cords, cicatrization has advanced from the surrounding skin, and the testicles and spermatic cords have become, in time, invested with a new covering adequate to their protection.

5. **Elephantiasis of the scrotum** is a disease peculiar to hot climates. It commences as a hard kernel under the skin, usually at the bottom of the left side of the scrotum; as it spreads in all directions, the skin over it becomes thickened and indurated, and appears furrowed, wrinkled, and glandular; the lower part of the abdomen is elongated by the traction of the skin; for the same reason, the penis diminishes in length.[2]

In the later stages the ruptured lymphatics allow lymph to transude from their extremities or walls which forms crusts; the tumor becomes altered in appearance and form, being smooth in contact with the thighs, and narrow above where it is attached to a sort of stalk, and large below, descending sometimes below the knee.[3]

Removal of the mass, when it becomes a great inconvenience, must be practiced. As expedition is of the greatest moment, the question of preserving the penis and testicles must first be positively determined.[1] The penis may generally be dissected out and saved, but when the tumor exceeds fifty pounds in weight, the testicles should not be saved.[4] The elastic bandage should first be applied to the mass and firmly fastened around the pedicle and hips. The penis should first be dissected out from the front of the tumor and then its pedicle is to be divided by rapid strokes of the amputating knife, the spermatic cords being seized to prevent retraction; if the gen-

[1] T. B. Curling. [2] Pruner. [3] Kaposi. [4] Esdaile.

ital organs are preserved, flaps must be formed, one in front to cover the penis, and two laterally to invest the testes; hæmorrhage must be arrested, during the operation, by pressure with dry sponges.[1] The after treatment is that of all large wounds of integument, the object being to secure prompt union.

6. **Varicocele** results from a varicose state of the veins of the spermatic cord, resulting in an enlargement of its tissues, forming a pendulous mass, which becomes a source of inconvenience. The early treatment is support by means of a suspensory bag. If the mass becomes a source of inconvenience, the varicose veins of the cord may be obliterated, or the mass may be excised. To avoid hæmorrhage the clamp should be used as follows: Draw the scrotum between the blades of a serrated clamp[2] (Fig. 562), until the requisite amount is inclosed; turn the screw *c*, and approximate the blades so as to firmly compress the inclosed tissues; with one sweep of the knife remove the redundant portion near the clamp; sutures should now be introduced thickly through the two flaps and firmly tied, when the clamp may be removed, or it may be retained partially loosened.

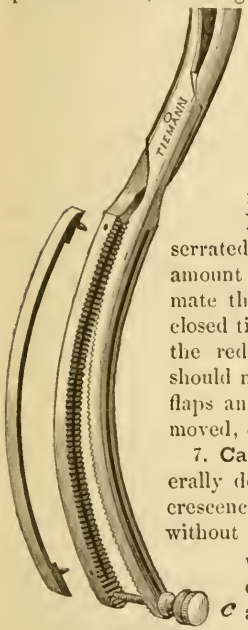


FIG. 562.

7. **Cancer of the scrotum**, epithelial,[1] is generally developed as a small pimple, or warty excrescence, which often remains for months or years without undergoing any change; there may be one wart, or two or three; after a time it becomes soft, excoriated, and red, and exudes a thin discharge, which dries as a scab; ulceration follows, characterized by an indurated base with elevated edges, and an irregularly excavated surface. There is no effectual remedy but the knife, and greater success attends removal than similar operations on other parts. The mass should be removed by two elliptical incisions.[3] If inguinal glands are involved, they may be successfully extirpated.

8. **Hydrocele** is an accumulation of fluid in the sac of the tunica vaginalis, and is caused by any condition which stimulates that membrane to over-secretion. It commences at the lower part of the scrotum and gradually extends upwards, and, when well marked, the tumor is tense, transparent, and fluctuating, has a smooth and uniform surface; the testicle is not defined, but the spermatic cord can

[1] T. B. Curling. [2] M. H. Henry. [3] Sir J. Paget.

be traced to the swelling;[1] if the hydrocele is old the walls may be so thick that the transparency is lost. The hypodermic syringe should be used in all doubtful cases. The palliative treatment is evacuation of the fluid by puncture, which may be done with the bistoury or trocar; the puncture should be made a little below the centre of the anterior part. Grasp the tumor in the left hand, the anterior surface being uncovered; avoiding veins, puncture with the instrument inclined slightly upwards and backwards, taking care not to penetrate so deeply as to wound the testicle. The radical treatment consists in injections of tr. iodine; or, incision, which is best performed as follows:[2] Shave the parts thoroughly and wash with a solution of carbolic acid; under the carbolic spray make an incision from the external ring to the base of the scrotum; wash out the sac with a three per cent. solution of carbolic acid; secure bleeding vessels with cat-gut ligatures; stitch the edges of the tunica vaginalis to the skin with the finest silk sutures, the wound remaining open; if the edges of the wound are so thick as to make it deep, insert a drainage tube; bandage the scrotum with eight to ten thicknesses of antiseptic gauze; lay a mass of gauze over the genitals, with an opening for the penis, so as to cover the groin and lower part of the abdomen, and bind it on with antiseptic gauze bandages; leave the dressings on three or four days, when the cavity will be obliterated by adhesion.

II. THE SPERMATIC CORD.

The constituents of the cord are the excretory duct, blood vessels, lymphatics, nerves, and cremaster muscle; it extends from the internal abdominal ring downward to the back part of the testicle.[3]

1. **Varicose veins of the cord** are more properly considered under the Diseases of Veins.

2. **Hæmatocele of the cord** results from rupture of a spermatic vein during violent and sudden exertion, or from contusion. It may be diffused or circumscribed. When diffused, it has been mistaken for hernia, but a careful study of the symptoms will determine the difference, or an exploratory incision may be made. The encysted variety is rare, and cannot certainly be diagnosed, except by puncture. The treatment should at first be cold applications; if the tumor does not disappear, but inflames, or is a source of annoyance, its contents should be removed, antiseptically, by incision.

2. **Hydrocele of the cord**[4] consists in the collection of fluid in some part of the cord; the sac is thin, and is, in most instances, an unobliterated portion of the canal of the tunica vaginalis, which has become distended by an accumulation of fluid in it; the tumor is usually oblong, transparent, and may exist as an independent cyst.

[1] T. B. Curling. [2] R. Volkman. [3] J. Leidy. [4] G. M. Humphrey.

The treatment is the application of tr. iodine, with pressure, which frequently induces absorption; if the fluid is encysted, it may be evacuated by puncture and the sac obliterated by an injection of tr. iodine.

III. THE TESTIS.

The gland consists of two parts, the epididymis and the body; the epididymis is the continuation of the spermatic cord, and is closely applied to the posterior part of the body; the body consists of the glandular structure, invested by a dense white membrane, the tunica albuginea.

1. **Hæmatocele**[1] consists of an effusion of blood either into the cavity of the tunica vaginalis, from a vessel ruptured by a blow, or into a hydrocele or cyst; when the enlargement immediately follows injury, and the parts are discolored, the diagnosis is easy; but when the affection is more chronic and the ecchymosis has passed away and been forgotten, the diagnosis is often very difficult. Apply cold to arrest bleeding and promote absorption; if the accumulation remain, and create irritation or inconvenience, puncture antiseptically and evacuate the blood; if suppuration occur, open the cavity, cleanse it with carbolic acid solution, and apply dressings as for an open abscess.

2. **Epididymitis** is caused by injuries, or by irritation in the urethra, especially about the orifices of the seminal ducts. It commences with tenderness and swelling of the lower and posterior part of the epididymis; the swelling extends until the whole epididymis is involved, serum and lymph being infiltrated into the connective tissue; the pain is often very severe in the early stages, being dull, heavy, and sickening.[1] On examination, the line of division between the soft testicle in front and the hard inflamed epididymis behind, can be readily traced. The treatment should depend upon the severity of the disease. In the gonorrheal form, all efforts to arrest the discharge must be abandoned. In general, direct the recumbent position, and support the parts in a suspender.

Double a handkerchief so as to form a triangle, the middle of the base, to which a piece of double tape has been sown, being applied to the perineum, and the extremities of the handkerchief carried forward and attached in front to a band round the waist, whilst the ends of the tape being secured to the band behind prevent the handkerchief slipping forwards.[2]

In mild cases it is often sufficient to secure rest, elevation of the organ with spirit lotions, or hot poultices and saline cathartics. In acute cases, apply a tobacco poultice as follows: Mix a paper of any fine-cut tobacco, ʒi. in ʒx. of hot water; raise it to a boiling point

[1] G. M. Humphrey. [2] T. B. Curling.

while stirring it briskly, and add ground flax seed, until the proper consistence of a poultice is obtained.[1] In obstinate cases, apply six to twelve leeches in the course of the cord above the inflamed part.[2] Ice is sometimes useful when the inflammation is severe, but it must be so applied and maintained as to preserve a uniform low temperature of the parts. When the inflammation subsides there often remains considerable enlargement, which may be reduced by uniform strapping.

The patient being placed in the recumbent position, with the testicle raised, is to remain there three or four minutes, in order to allow the vessels of the gland to become as empty as possible. The parts are to be shaved; and some adhesive plaster or chamois leather must be cut into strips, about three quarters of an inch in width, and eight or nine inches in length. The opposite testicle and side of the scrotum being drawn away from the diseased one, so as to render the integuments of the latter quite tense, the first strap is to be placed circularly (Fig. 563) around the cord, just above the testicle, as tightly as the patient can bear it; a strip of lint may be placed beneath the edge of the plaster to prevent its irritating the scrotum; the second strap is to be placed in an opposite direction, from behind forwards, at the side of the testicle, near the septum; the third strap is to be applied below the first, so as partly to overlap it; and the fourth in like manner, internal to the second, and so on until the straps meet, and the whole of the testicle is covered and evenly compressed.

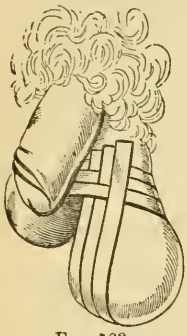


FIG. 563.

3. **Syphilitic orchitis**, inflammation of the gland from syphilitic poison, occurs in the tertiary stage of that disease.

The disease appears in two forms.[3] The first is simply inflammatory; the mischief sets out from the interstitial structures in a hyperplastic growth of young connective tissue, followed by fibroid condensation; the white fibrous bands may be distinguished by the naked eye, conoidal in shape, determined by the lobular segmentation of the organ; finally, nothing is seen beyond a mass of white fibroid tissue, all trace of the old divisions of the gland having disappeared with the tubuli seminiferi. The formation of gummata is to be regarded as only a further specialization of the morbid process; several nodules of the size of a cherry-stone are usually scattered through the fibroid mass; the specific changes set out from a proliferation of the corpuscular elements of the connective tissue followed by a fatty degeneration.

The enlargement of the testis usually takes place gradually and without pain, except perhaps along the cord, and is generally discovered by accident; it may be perfectly smooth, and hard as wood, but usually is nodular, and insensitive on pressure.[1] The treatment should be with mercury and iodide of potassium, as in the following

[1] Van Buren and Keyes. [2] T. B. Curling. [3] E. Rindfleisch.

formula: potas. iodid. ℥i., hydrarg. bichlor. gr. ss., syr. sarzæ, tr. cinch. co. āā. ℥ij. M.; take one teaspoonful three times daily.[1]

If the surface is broken and a fungus appears, it should not be treated by excision but by strapping and nitrate of silver; removal of the enlarged organ should not be attempted until a thorough course of anti-syphilitic treatment has been tried faithfully, and with large doses of iodide of potassium.[2] The testis should at all times be properly supported by a suspensory bandage.

4. **Tubercles of the testis** consist of certain cheesy nodules of considerable bulk and more or less globular shape, commonly multiple for a time, but finally they coalesce to form a single mass, remarkable for its peculiar elasticity, which it retains until a central softening leads to an abscess; this tends to burst and give rise to the well-known fistula which is remarkable for its extreme chronicity, and occasional discharge of sodden shreds of seminiferous tubuli through it.[3] Suppuration rarely occurs in children.[4] The treatment should be largely hygienic, as exercise in the open air and nutritious food; quinine, iron, and cod-liver oil are the most useful remedies; the testis must always be supported. Castration is required only in extreme cases, and must not be performed if there are signs of advanced disease in the lungs.[4]

5. **Sarcoma**[3] in all its principal varieties finds a favorite seat in the testicle; the tumor almost always contains not only all the chief varieties of sarcoma, but all the histioid formations which are met with in the sarcomata as well; cartilage, mucous and connective tissue, striped and unstriped muscle, enter more or less into the composition of the sarcomata of this organ; these frequent combinations introduce an element of great variety into the structure of the sarcomata of the testicle, and this is rendered more manifold by the frequent occurrence of cysts in their interior. The growth is slow, usually painless, oval, and smooth. The treatment is removal of the gland.[5]

6. **Cancer** of the soft variety, fungus hæmatoides, is not easily distinguished from soft sarcoma; it is the only form which primarily attacks the testicle. It develops rapidly, is uneven, with hard and soft spots, the pain is often severe, and the tumor may attain to an immense size. Early extirpation is the only remedy.

7. **Castration**[4] is an operation simple, easy of performance, and nearly free from danger. Shave the hair from the pubes and scrotum; the patient being properly placed, and under ether, make an incision from about half an inch below the external ring along the front of the tumor to the bottom of the scrotum; divide the envelopes of the cord and testicle, the layers of the thickened fascia, and the cremaster muscles nearly as high as the ring; expose the spermatic

[1] V. Mott. [2] Van Buren and Keyes. [3] E. Rindfleisch. [4] T. B. Curling. [5] T. Billroth.

cord, and detach it from the surrounding parts; if the division is to be made high up, pass a very stout double ligature through it, tie firmly each half, and sever the cord below; if the division is near the testis, grasp the cord firmly with the fingers, cut it below, and tie the arteries separately, first the spermatic artery, and next the artery of the duct; the gland is next to be removed, partly by tearing it from its connections, and all bleeding vessels tied; the wound should be closed by sutures, except at the lowest angle; a drain-tube should be introduced.

CHAPTER LI.

THE PROSTATE GLAND.

This body[1] is situated between the neck of the bladder and the triangular ligament, and surrounds the first portion of the urethra.

It is usually from one to one and a half inches in length and breadth, and about three fourths of an inch in thickness; its apex adheres to the triangular ligament, and its notched base encircles the neck of the bladder; the lateral portions form the lateral lobes, and the isthmus which unites them beneath the neck of the bladder is called the middle lobe.

1. **Injuries** of the prostate usually occur during operations involving the bladder and urethra. They can only be treated by rest and cleanliness; if urinary extravasation occurs, or abscess forms, free incisions are necessary to prevent further accumulations.

2. **Hypertrophy**[2] of the prostate takes two forms; in the less common variety there is a uniform enlargement of the organ in all its dimensions and a marked increase in its density, due to the presence of an exceedingly tough, inelastic, whitish, fibrous tissue which permeates the entire gland; the muscular bundles are all in a state of overgrowth, while the gland-tubuli waste and disappear. In the more usual form there are discrete nodules in the substance of the gland, rounded in form, containing both glandular and muscular elements; the manifold varieties of external form presented by the hypertrophied prostate, the implication now of its right, now of its left lateral lobe, and then of its middle lobe, the immense variety of distortions and dislocations to which the prostatic part of the urethra may be subjected, are phenomena easily explained by the lack of uniformity in the distribution and rate of growth of the nodules. The first effect on the prostatic urethra is increase of its antero-posterior diameter, with diminution of its lateral or transverse diameter, the canal becoming a narrow passage, instead of one which, when distended, is of about equal diameter in every direction; the

[1] J. Leidy. [2] E. Rindfleisch.

length of the prostatic urethra is also materially increased, and is often tortuous; the natural direction also deviates, namely, where the median portion is enlarged, the urethra suddenly rises, producing an angular curvature in place of a nearly straight line; if there is also enlargement of either lateral lobe, the lateral direction of the canal is also changed, the convexity being towards the large lateral lobe.

The most important result of enlargement is obstruction to the flow of urine, but the symptoms not unfrequently exist long before the real cause is suspected; there is more frequent desire to pass water, but the force is diminished; a disagreeable sense of weight and fullness is experienced about the perineum; cystitis follows; then pyelitis, and the patient is finally worn out with suffering. But the test chiefly depended upon is digital examination by the rectum, as follows:[1] Place the patient on his back on a couch, with his knees drawn up and separated a little; standing on his right side, introduce the index finger of the left hand slowly through the sphincter, and when two phalanges are free in the rectum, define the size, form, and consistence of the prostate; then, with the right hand, so manage the catheter introduced through the urethra as to determine the thickness of tissues, and the direction of the canal. Now withdraw the finger, and explore with the ordinary catheter; if it pass as usual, and water flows at the depth of six to eight inches, the evidence is against hypertrophy; but if the instrument passes nine or ten inches and no urine escapes, and the handle is unusually depressed, there will be little doubt of enlargement; a prostatic catheter should now be used, which is two to four inches longer, with a larger curve, and the direction which it takes, the depth at which water begins to flow, and other facts noted. One of the best evidences of hypertrophy is the flow of urine through the catheter, passed immediately after the patient has evacuated the bladder.[2] The only operative treatment should be that which is designed to obviate the results. This is done by completely evacuating the bladder at least once a day with a catheter. As a rule, the catheter should not be retained long in the urethra; if, however, it is found necessary to procure sleep or rest, the vulcanized instrument may be retained either by a string attached to its external extremity and fastened around the body of the penis, or by using a winged catheter (Fig. 564). All forms of direct medication have proved useless.

The catheter is stretched upon the stilet, and fastened to the handle ready for introduction, which is effected as follows: Suppose the catheter a No. 8 guage; insert the stilet and draw the India-rubber upon it towards the handle, until the size of the catheter is reduced to a No. 4; fix it in that situation by

[1] Sir H. Thompson. [2] R. F. Weir.

tying a piece of string immediately in front of the puckered portion, and fasten it to the hole in the handle; thus the calibre of the catheter is reduced one half, and will easily enter the bladder; the string may now be untied, and the catheter will resume its ordinary size; where the urethra is sufficiently capacious, the catheter, previous to being used, may be passed into a No. 12 silver catheter having an opening at the end, and when in the bladder the silver catheter may be withdrawn.

Fig. 564.[1]

Great difficulty is often experienced in passing a catheter through the prostatic urethra, owing to its irregularities, and many modifications of catheters have been made to meet these peculiarities. Of these the most useful are the single (Fig. 565)[2] and double elbow catheters (Fig. 566),[2] the ends of which keep closely applied to the roof of the urethra. In some cases the canal is more readily traversed by the vertebrated catheter.[3] In very tortuous passages a prostatic guide,[4] with spiral shaft (Fig. 568), will follow the devious route more certainly than even the vertebrated catheter (Fig. 567).

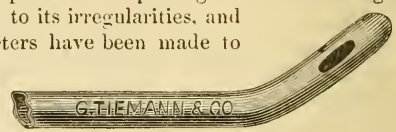


Fig. 565.

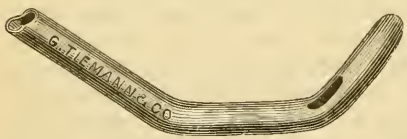


Fig. 566.

The prostatic guide consists of a slight steel rod, A (Fig. 568), eight inches in length, upon which is screwed a spiral ribbon, B, five inches in length. The union is strengthened by the projection of the end of the rod into the spiral, for half an inch beyond the screw, C. This spiral ribbon is so flexible that it can easily be made to take the curve of the urethra, or any irregularity in its course which may

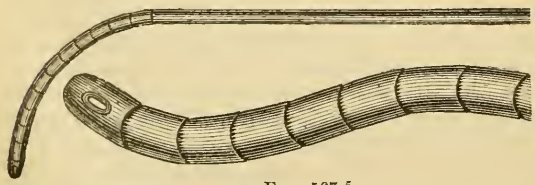


Fig. 567.[5]

[1] G. Tiemann & Co. [2] A. Mercier. [3] T. R. Squires. [4] F. N. Otis.
[5] Stohlmann, Pfarre & Co.

present. Its small size may make it capable of being easily introduced into a soft rubber catheter, and by means of it the catheter may be carried down and along the urethra to and into the bladder, following any deviation in the course of the canal which may be present from prostatic enlargement or other causes.

FIG. 568.

CHAPTER LII.

THE PENIS.

THE penis is composed principally of an erectile tissue arranged in masses which occupy three long and nearly cylindrical compartments, namely, two, the corpora cavernosa, placed side by side, which form the principal part of the organ, and the corpus spongiosum, which surrounds the canal of the urethra; it is attached to the pubic arch by its root, and in front ends in the glans which is continuous with the spongy body; the integument of the penis is continued from that of the pubes and scrotum and forms a simple investment as far as the neck of the glans, where it is doubled up in a loose cylindrical fold constituting the prepuce.[1]

1. **Injuries** of the penis occur in many forms. The organ may be fractured by being forcibly bent when erect;[2] the treatment is cold. Contusions rarely require other measures than such as prevent inflammation. Wounds are to be treated as other wounds, care being taken to prevent urinary infiltration and curvatures in cicatrization.

2. **Phimosis** is such a contraction of the prepuce that the glans cannot be uncovered; in the normal condition of the infant the prepuce is adherent to the glans, but later these adhesions are broken down and the prepuce becomes free. If, however, there is inflammation excited by irritants, as accumulations of filth under the prepuce, these adhesions may become firm; or, the orifice may become inflamed and so dense that it will not yield, even to allow the free passage of urine. The affection may be a source of great discomfort in children, resulting in spasms of the muscles of different parts of the body,[3] and in adults, of collections of filth and foul matters. The treatment is circumcision. In performing this operation it is important to seize the orifice of the prepuce for the purpose of making suitable traction on the mucous membrane, which is but slightly elastic compared with the skin. First insert a well-oiled probe under

[1] Quain's Anatomy. [2] V. Mott. [3] L. A Sayre.

the prepuce and sweep the surface of the glans to break up adhesions; seize the orifice of the prepuce, at opposite points, with sharp-toothed forceps, drawing the whole forwards until the mucous membrane is put well upon the stretch (Fig. 569); grasp the prepuce firmly just in front of the glans with a clamp, or forceps; with the bistoury cut away the portion anterior to the clamp; if the prepuce readily retracts, the angles may be cut away, and the mucous and skin flaps united by a number of fine sutures; if the prepuce is not free, all tightness must be relieved by an incision on the dorsum, or, in infants, by tearing the tissues; the cut mucous membrane must be attached to the skin by numerous fine sutures beginning at the raphé; rest and water dressings are only required in the after treatment.[1] In slight cases it may be sufficient to slit up the prepuce on the dorsum, and attach the edges as before. If there is a contracted prepuce, after the excision [2] slit up the skin three to six lines on the dorsum of the penis (Fig. 570), trim the corners round, 5, 4, 6 (Fig. 571), incise the mucous membrane 2, 1, 3 (Fig. 571), adjust the point 1 to 4, 2 to 5, and 3 to 6, with sutures, and the rest of the circumference by a sufficient number to hold them in position.[3]

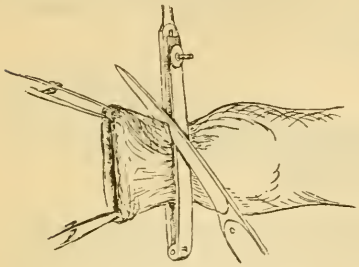


Fig. 569.

Fig. 570.

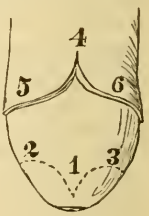


Fig. 571.

3. **Paraphymosis** [1] occurs when the prepuce is withdrawn behind the glans and cannot be brought forward; the prepuce forms a constricting band around the corona, which is followed by swelling of the glans and œdema of the prepuce. The treatment is prompt reduction. If the swelling is slight, and without strangulation, reduction may be effected by the methods given below, or by strips of rubber plaster applied longitudinally from the middle of the penis on one side over the apex of the glans to the middle of the penis opposite, the meatus being left uncovered, until the organ is covered. If there is dangerous strangulation shown by the dark color of the glans, and great œdema of the prepuce, reduction is more difficult, but may be aided by employing cold, and puncture of œdematous

[1] Van Buren and Keyes. [2] E. L. Keyes. [3] L. A. Stimson.

parts. Reduction is effected as follows: Give an anæsthetic; seize the penis behind the strictured prepuce, between the index and middle fingers of both hands, placed on either side (Fig. 572), make pressure with the thumbs on both sides of the glans, in such direction as to compress the glans laterally, rather than from before backward, and at the same time pull the strictured portion of the prepuce forward; the manipulation is designed to reduce the glans by compression, and pull the stricture over the glans, and not to push the glans through the stricture.

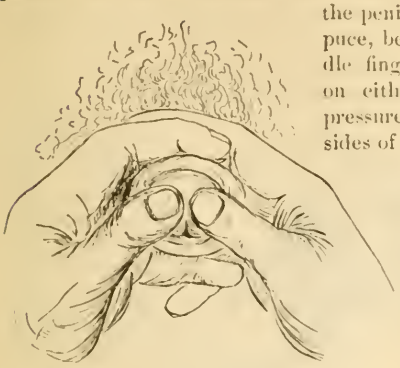


FIG. 572.

Or, the penis may be encircled with one hand (Fig. 573), while compression is made with the thumb and finger as before. Or, place the index and middle finger of the right hand longitudinally along the lower surface of the penis, and the pulp of the thumb on the dorsum of the glans and the œdematous ridge in front of the point of stricture (Fig. 574); by firm pressure crowding down the swollen mucous membrane of the prepuce, endeavor to insinuate the end of the thumb nail under the stricture; succeeding in this, grasp the penis and the two fingers of the right hand beneath, in a circular manner, with the left hand, and draw the strictured point up over the thumb nail, and by simultaneous traction of both hands replace the prepuce.[1] If a prolonged and careful attempt at reduction fails the strictured point must be divided as follows: Introduce a tenotomy knife flatwise along the sheath of the penis, subcutaneously, under the stricture, and cut outward until all tension is removed; or, a simple incision may be made down to the sheath of the penis. The after treatment consists of cleanliness and syringing the preputial cavity with carbolized water.

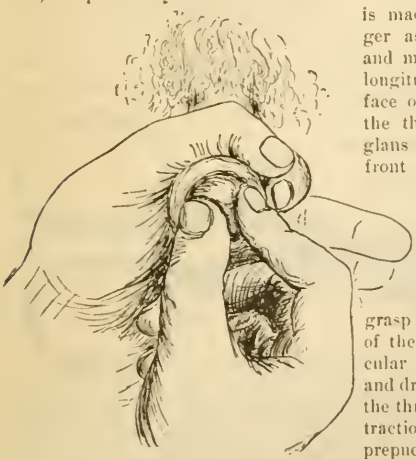


FIG. 573.

4. **Cancer** of the epithelial variety most frequently affects the

[1] A. Mercier.

penis; it may occur on the prepuce, but usually it appears on the glans as a firm, warty elevation, having a broad base; it slowly increases, without pain, at first covered with a more or less thick cuticular crust, which leaves a bleeding surface when removed; in its progress it destroys the glans, opens the urethra, involves the prepuce, finally affects the glands of the groin, and proves fatal, by irritation, and discharges from progressively spreading ulceration.[1] The treatment is extirpation. If the prepuce alone is affected, circumcision must be performed. If the glans is slightly affected, the diseased part may sometimes be excised without injuring the urethra. In general, amputation through the anterior part of the penis is performed, as follows: Inclose the organ at its root in a clamp[2] like that used for hæmorrhoids (Fig. 575), or apply a tape to prevent hæmorrhage; divide the organ at a stroke, the skin being slightly retracted, owing to its tendency to excessive retraction; ligate all the vessels, then slit the urethra above slightly and below to the extent of half to two thirds of an inch to render the new opening patulous after cicatrization; now carefully connect the urethral margin to that of the skin by many fine sutures, commencing at the lower angles. Apply cold dressings.

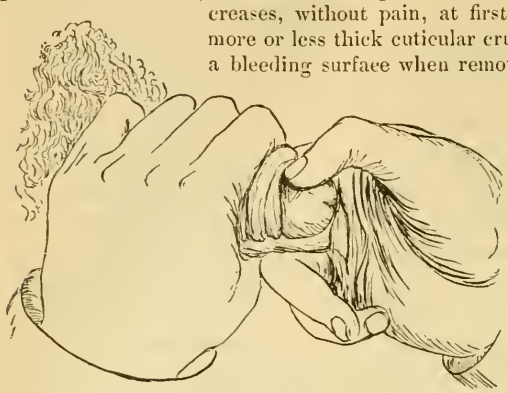


Fig. 574.

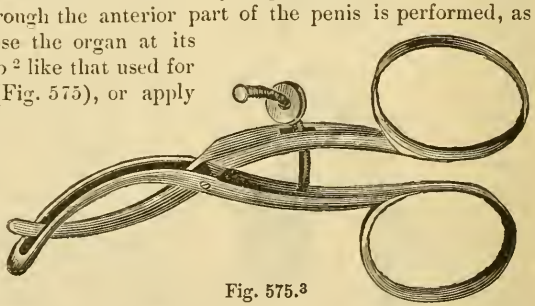


Fig. 575.[3]

If the disease involve the penis at a higher point, it may be necessary to extirpate the organ altogether, as follows[4]: The patient having been etherized,

[1] G. M. Humphrey. [2] W. Bodenhamer. [3] G. Tiemann & Co.
[4] J. W. S. Gouley.

make a curvilinear incision on either side of the root of the penis, beginning in the median line, at about one inch and a half above the level of the pubes, and ending a little below the peno-scrotal junction; this elliptical wound exposes the cavernous bodies, which may be transfixed by a large knitting-needle, the ends of which rest on either groin and serve to prevent retraction of the stump; pass a smaller knitting-needle across and through the urethra on the same plane as the first needle, and with [1] serrated scissors sever the penis at a point about one eighth of an inch anteriorly to the needles; four or five vessels require the ligature besides those of the subcutaneous tissue, which are secured in the pubic and scrotal portions of the wound; the mouth of the urethra is easily found on account of the needle, and a grooved staff is introduced through it into the bladder; plunge a scalpel into the centre of the perineum and into the groove of the staff, and divide all the tissues, including the skin, at one sweep of the knife from behind forward and from below upward; the urethral cut is about an inch and a quarter in length, including half of the bulb, and the cutaneous wound three inches; detach the urethra from the cavernous bodies, slit it longitudinally, and stitch its free extremity to the upper commissure of the perineal wound and its edges to the skin.

THE FEMALE ORGANS.

CHAPTER LIII.

THE OVARIES.

These bodies correspond to the testicles of the male; they are somewhat flattened and oval, and are placed on each side of the uterus, at the back of the broad ligament, and are enveloped in its posterior membranous layer; each ovary is free on its two sides, and along its posterior border, which has a convex outline, but is attached by its anterior border.[2]

I. INFLAMMATION.

Ovaritis may become a powerful disturbing element in the physical constitution of woman; in some cases the ovarian pain and exacerbation of sufferings at the menstrual epoch are almost unbearable, in others it causes such violent disturbance of the vascular and nervous systems that life is jeoparded; occasionally it terminates in epilepsy or insanity, and ultimately in death.[3] In these extreme cases extirpation of the ovaries has been performed with success. The mortality is very great, being eleven deaths in thirty-six cases.[4] The object sought is the artificial production of the menopause, or

[1] Richardson's. [2] Quain's Anatomy. [3] J. M. Sims. [4] Engelman.

the cessation of menstruation.[1] In this view the question of extirpation has been determined as follows:[2] —

(1.) In cases of amenorrhœa where there is no uterus, or only the rudiments of one, or where there is an incurable atresia uteri, and the menstrual molimen produces such violent disturbance of the whole system as to destroy health and endanger life, the removal of the ovaries is the only means of permanent relief. (2.) In cases of prolonged physical and mental suffering attended with great nervous and vascular excitement produced by perturbed menstrual molimen, whether menstruation be absent, scanty, or otherwise, this operation is justifiable after all the usual remedies fail to relieve. (3.) In cases of incipient insanity and of epilepsy depending upon ovarian and uterine disease this operation is justifiable after all other remedies have failed to cure. (4.) In cases of fibroid tumors of the uterus attended with incurable hæmorrhages that endanger life, when the tumors cannot be safely enucleated and removed, this operation may be resorted to with the hope of arresting the bleeding and the prospect of diminishing the tumors. (5.) In cases of chronic pelvic cellulitis and of recurrent hæmatocele, when the attacks are traceable to the disturbing influences of the menstrual molimen, we may have recourse to this operation as a dernier ressort.

The operation may be performed through the abdominal or vaginal wall and the following rules are given:[2] (1.) Remove both ovaries entire in every case. (2.) As a rule, operate by the abdominal section, because, if the ovaries are bound down by adhesions it is possible to remove them entire, whereas by the vaginal incision it is impossible. (3.) If there has been no pelvic inflammation, no cellulitis, no hæmatocele, no adhesion of the ovaries to the neighboring parts, then the operation may be made by the vagina, but not otherwise.

1. **Removal by abdominal section** requires the same incision and procedure as in the removal of ovarian growths.

2. **Extirpation of the ovary** through the vagina is performed as follows:[1] The patient, having been fully etherized, must be placed upon the table in the prone posture;[2] now retract the perineum by a speculum; grasp the cervix uteri with a volsella and draw the uterus firmly downwards; make an incision through the walls of the vaginal cul-de-sac in the line of the fornix vaginæ; control the slight hæmorrhage by cold sponges; grasp the peritoneum, nick and open it to the length of the original incision; pass the forefinger into the cul-de-sac, and examine the ligaments and Fallopian tubes, and determine the position of the ovaries; draw one as closely as possible to the incision, grasp it with forceps, draw it through the opening into the vagina, pass a stout ligature around the pedicle, apply the chain of the écraseur and slowly sever the attachments; pursue the same method with the other ovary; cleanse the vagina, and secure quiet and rest.

[1] R. Battey. [2] J. M. Sims.

II. CYSTIC TUMORS.

These tumors assume many forms; they may be large and small, simple and compound, and may have watery, colloid, fatty, sanguinolent, or mixed contents.[1]

The more important are the colloid cysts,[2] characterized by thick, viscid, frequently yellow or brownish gelatinous contents; they are always multiple at the outset, multilocular cysts, and are usually present in large numbers; in cases of long standing it often happens that one or several cysts are much larger than the rest, and finally there may be but one present, unilocular cyst, which is formed by the union of many smaller ones; as the manner of growth of these cysts has a great resemblance to that of the normal Graafian follicles, they have been called adenomata. By a conversion of the colloid contents into a more fluid substance, and by a constant secretion of liquid from the walls, the epithelial cells of which often perish, what is known as multilocular ovarian dropsy originates. Polypoid growths are often seen on the inner surface of these cysts, and extend into their interior; the cysts may undergo secondary changes by the admixture of blood with their contents, which gives them a brown color. Suppuration may take place from the wall, and the contents may become ichorous, usually in consequence of operative interference. In the case of large cysts, adhesions to the abdominal walls, intestine, etc., are almost constant. Besides the pure cystomata there are a large number of cystic tumors of different natures, for most ovarian tumors are prone to become cystic; thus there is a cystofibroma, cystocarcinoma.

Cysts of the ovary are diagnosed from solid tumors by fluctuation; from ascites by the limited extent of the wave-impulse;[3] from tumors of the uterus by their location, exploration of the cavity of the uterus by sounds, examination by the hand in the rectum,[4] tapping or testing the fluid. The treatment is tapping or extirpation.

1. **Tapping the ovary** should be preferred when the cyst is single, and no secondary growths can be detected in the cyst wall; if the operation be performed with precaution, the risk is extremely small, the patient loses nothing, and a cure may follow.[3] The operation

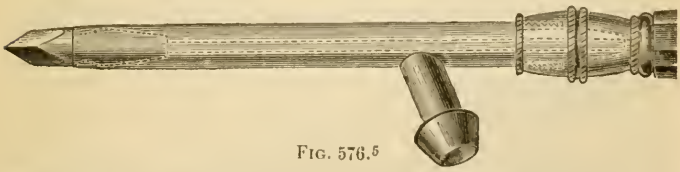


FIG. 576.[5]

may be performed through the abdominal wall, the vagina, or rectum. When the abdominal wall is selected, the only danger is wound of a blood vessel, and the entrance of air into the cavity of the cyst; the former accident is so rare as to require no considera-

[1] E. Rindfleisch. [2] J. Orth. [3] T. S. Wells. [4] Simon.
[5] Geo. Tiemann & Co.

tion;[1] the latter may be prevented by antiseptic measures, or the use of a proper trocar and canula (Fig. 576).[2]

The trocar is withdrawn after the puncture; the canula being within the cyst the fluid escapes through the rubber tube attached to the button on the side; the extreme end of the tube is immersed in a tub of water.

The preparation of the patient and the details of the operation are the same as in paracentesis abdominis. It is important to observe the following rules:[3]—

(1) Never tap while the patient sits, but always as she lies upon the side or back; (2) cut the skin with a lancet, and employ a trocar and canula with tube immersed in water to prevent the entrance of air; (3) if the fluid withdrawn is viscid, always wash out the cavity of the sac with warm carbolized water; (4) should there be oozing of blood, pass a harelip pin deeply through the lips of the wound and affix the figure-eight ligature; (5) keep the patient recumbent and very quiet for two or three days.

Tapping by the vagina is more liable to be followed by the entrance of air into the cyst, suppuration, and fever.[4] It is most useful when the cyst is found fixed in the pelvis, as it may be followed by drainage and antiseptic injections. Place the patient in the lithotomy position, the bladder and rectum having been evacuated; introduce the index and second fingers into the vagina until they rest upon the most prominent part of the tumor; carry a canula ten inches long, with the trocar slightly withdrawn, along the finger, and plunge the trocar into the cyst, after the fluid has escaped, secure perfect quiet and guard against inflammation.[3]

Electrolysis has been strongly recommended for its power to promote absorption as a reliable method of treating ovarian tumors, but, judging from statistics and general considerations,[5] it would seem that it can in nowise supplant ovariotomy.

2. **Ovariotomy**[1] is an extreme measure, and though very successful as regards mortality, should not be advised without due deliberation. In general, it should not be recommended while the patient is moderately comfortable; while she can walk a mile, or for half an hour, without much inconvenience; while she can get up and down stairs; while there is no great pressure upon any of the organs of the abdomen or pelvis; when she can breathe pretty well the heart is not affected. The proper time for surgical interference is when the patient is so far inconvenienced by the tumor and so much distressed from its size, that she cannot move about without great discomfort, her general health is suffering, she is losing her rest, becoming thin, and some serious damage is being done by the pressure of the cyst; but the operation must not be put off until there is no reasonable hope

[1] T. S. Wells. [2] T. A. Emmet. [3] T. G. Thomas.
[4] T. S. Wells; T. G. Thomas. [5] P. F. Mundé.

of success. Almost positive contra-indication to an operation would be the fact that the patient has some other disease which, if left to its natural course, would certainly prove fatal.[1]

The operation having been determined upon, every precaution must be taken to render it successful. The patient must be lodged in the best house, in the best sanitary condition, and in the best room that can be secured.[1] As antiseptic precautions have added greatly to the safety of the operation the room should be thoroughly disinfected, either by sulphur[2] or carbolic acid;[3] the attendants, assistants, and operator should be entirely free from every form of contagious and putrescible matter, both as to their persons and clothing; the air of the room should be pure and may be disinfected with the finest carbolic fog before and during the operation, created by a proper steam atomizer; all the sponges, instruments, and dressings should be carbolized. Proceed as follows: [1] Place the patient on a table, wrap the feet and legs with a sheet, fasten a strap over her knees, and tie the hands to the legs of the table with an ordinary bandage looped over the sleeve; give the anæsthetic; the patient and bedding are protected by a sheet of waterproof cloth, with a hole in the centre, around which, on the inside, adhesive plaster is spread to the extent of an inch to an inch and a half; when this sheet is thrown over the patient, the plaster adheres to the skin of the abdomen; the body, clothing, and face is protected from the spray, if that is used; make the incision with an ordinary scalpel, along the linea alba, below the umbilicus, and expose the peritoneum; sup-

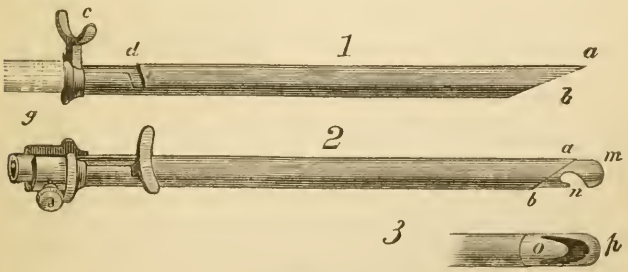


Fig. 577.[4]

press all bleeding by seizing the vessels with artery forceps; divide the peritoneum by catching it up with forceps, or a little hook, avoiding the cyst which may lie close against the abdominal wall; nick the peritoneum with the scalpel laid flat, pass a broad director into the opening, and with a blunt-pointed knife divide this membrane

[1] T. S. Wells. [2] Hegar. [3] Hegar; Keith. [4] S. Fitch.

three or four inches, as may be necessary, and expose the cyst; now empty the cyst with a trocar (Figs. 577, 578), draw the tumor out of the abdomen until the pedicle comes into view, when the clamp is applied (Fig. 579).[1]

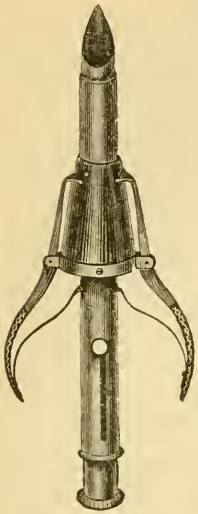


FIG. 578.[2]

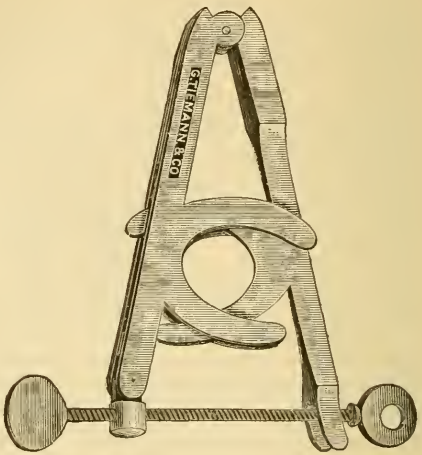


FIG. 579.

The dome-trocar[3] (Fig. 576) is represented in 1, 2. 3; the distal orifice of the inner canula, *l*, is closed over by a rounded or dome-shaped roof, *m*, so that, when it is projected beyond the cutting-point of the outer canula, the two tubes, *a*, *m*, fit closely together, and the end of the combined instrument feels perfectly smooth like the end of a sound or catheter, and may be freely moved within the cavity penetrated, as the ovarian cyst, the abdomen, the thorax, the bladder, or even the pericardium, without danger of wounding any viscus or organ, puncturing any vessel, or even scratching or abrading the lining of the cavity, or of any parts contained therein; the base of this dome being of the same external circumference as the inner tube, of which it is the continuation, and fitting the outer tube accurately, when the point of the instrument enters a cavity there can be no escape of fluid, till the dome is advanced, occluding the cutting-point of the outer tube; then there is disclosed a fenestra or oval aperture on the under side of the inner tube, *n*, cut out of the lower wall and one third of each side wall, of the full size of the bore of the tube, and by which the fluid may be freely evacuated; the thumb-rest, *c*, attached to the inner canula may be pushed forward in the slot *d*, and turned into the branch-slot *e*, advancing the dome and bringing the fenestra to the under side. The tubular handle has the larger end fastened upon the outer canula by the screw *g*. In attaching the larger end of the handle to the outer canula, push the process, projecting from this end, into the slot in the proximal end of the canula, and then turn the loose ferrule till the mortise in its side corresponds to the screw *g*.

The mode of dealing with adhesions is as follows:[4] If the cyst is found closely

[1] T. G. Thomas. [2] G. Tiemann & Co. [3] S. Fitch. [4] T. S. Wells.

adherent to the walls, the safest plan is to empty the principal cyst before making any attempt to separate the adhesions, for the peritoneum being undisturbed, the fluid escaping from the cyst cannot pass into the peritoneal cavity; when the cyst is empty it is often extremely easy to draw it out by passing one hand into the interior, then grasping the back of the cyst and inverting it, drawing out the back part first. If this cannot be done, proceed to enlarge the wound and find exactly where the limit is between the cyst and abdominal wall, and proceeding to that point, with one hand draw the cyst outwards, while with the other separate the adhesions; occasionally firm bands must be separated with the knife or scissors.

The peritoneal cavity is now thoroughly cleaned with sponges, and the sutures applied; these sutures are silk, each end being threaded to a needle, and kept wrapped in carbolized gauze; with a needle-holder, each needle is passed from within outward, a sponge being placed over the bowels to catch any drop of blood, by taking up one side of the wound in the thumb and finger, and passing the needle from within outward, through the whole thickness, and then the other side is raised and the other needle is passed in the same manner; the intestines cannot be penetrated when this precaution is taken; pass five, six, or eight, according to the length of the incision; now remove the sponge, and while an assistant supports the sides of the abdomen, tie the sutures with the surgeon's knot; dry dressings are applied and strips of plaster to retain them in place, with a flannel bandage.[1]

As a means of controlling high temperature, after the operation, affusion has been successfully practiced.[2] The bed[3] on which the patient lies consists of a strong, elastic, cotton netting, manufactured for the purpose, through which water readily passes to the bottom below, which is of rubber cloth, so adjusted as to convey it to a vessel at the foot. Upon this cot a folded blanket is laid so as to protect the patient's body from cutting by the cords of the netting, and at one end is placed a pillow covered with India-rubber cloth, and a folded sheet is laid across the middle of the cot about two thirds of its extent. Upon this the patient is now laid, her clothing is lifted up to the arm-pits and the body enveloped by the folded sheet, which extends from the axillæ to a little below the trochanters. The legs are covered by flannel drawers and the feet by warm woolen stockings, and against the soles of the latter bottles of warm water are placed. Two blankets are then placed over her, and the application of water is made. Turning the blankets down below the pelvis, the physician now takes a large pitcher of water at from 75° to 80° and pours it gently over the sheet. This it saturates, and then, percolating the network, it is caught by the India-rubber apron beneath, and, running down the gutter formed by this, is received in a tub placed at its extremity for that purpose. Water at higher or lower degrees of heat than this may be used. As a rule, it is better to begin with a high temperature, 85° or even 90°, and gradually diminish it. The patient now lies in a thoroughly soaked sheet with warm bottles to her feet, and is covered up carefully with dry blankets; neither the portion of the thorax above the shoulders nor the inferior extremities are wet at all; the water is applied only to the trunk.

[1] T. S. Wells. [2] T. G. Thomas. [3] G. W. Kibbee.

CHAPTER LIV.

THE UTERUS.

The uterus is a hollow organ, having an average length of three inches, a breadth at its widest part of two inches, and a thickness of one inch; its position corresponds with the axis of the inlet of the pelvis, its upper end being turned upwards and forwards; it is covered behind, above, and in front, except where it is connected with the base of the bladder, by the peritoneum; from its lateral surfaces the peritoneum is reflected, forming the broad ligaments; its neck is narrow and round, from six to eight lines in length, and projects into the upper end of the tube of the vagina; at the lower extremity is the os uteri, by which its cavity communicates with the vagina.[1]

1. **Exploration of the cavity of the uterus** is made with the uterine sound, by which it is possible to ascertain the capacity of the uterus; the existence of growths within it; deviations of the course of its canal; differentiation of displacements from uterine tumors; the existence of endometritis; the mobility of the uterus.[2]

The uterine sounds *a*, *b*, *c* (Fig. 580), usually of metal, may be curved to suit any canal. For measuring the cavity, buttons may be applied to the shaft, *c*;[3] the end of the probe being in contact with the fundus, the section having a button on the end is projected until it comes in contact with the cervix, and the distance from the button to the end of the sound is the length of the cavity. A slender rod of whalebone, ending in a knob,[2] is useful for measuring a uterus enlarged by a submucous fibroid, and for separate measurement of the neck and body.

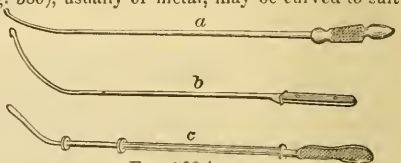


FIG. 580.[4]

Place the patient on the back, and ascertain by the touch the position of the uterus; then introduce the speculum, and pass the sound curved according to the direction of the uterine canal; if it does not pass, change its curve to meet deviations, for success is attained only by properly curving the probe.[2]

The tent is employed to dilate the cervical canal to allow of the examination of the cavity by the touch or sight; it may be made of sponge or of sea-tangle, laminaria digitata. The following rules[2] in regard to their use should be observed: —

(1) No force should be used in their introduction; if the first tent does not pass easily, withdraw it, and either bend it to a more suitable shape, or select

[1] Quain's Anatomy. [2] T. G. Thomas. [3] A. J. Skene. [4] Tiemann & Co.

a smaller tent. (2) Never introduce a tent at your office and allow the patient to go home with it in utero. (3) The previous existence of chronic pelvic peritonitis contra-indicates the tent. (4) A tent should never be allowed to remain in the uterus more than twenty-four hours. (5) After removal of a tent, wash out the vagina with antiseptic fluid; and, if there is pain or chilliness, give opiates. After the removal of a tent, the patient should be kept in bed for twenty-four hours.

2. **Cervical constriction**, causing dysmenorrhœa, is best treated by making a superficial incision through the submucous layers of the parenchyma from the os internum through the whole course of the canal. Introduce the hysterotome (Fig. 581)[1] up to the os internum, turn the screw at the end of the handle, by which the two blades are thrown out, and withdraw the instrument; place within the canal a roll of cotton saturated with a weak solution of persulphate of iron, and allow it to remain forty-eight hours; at the end of a fortnight replace it by a stem of glass or vulcanite.

Fig. 581.[2]

The stem should measure two inches, and rest by its globular base in a cup fixed between the bars of a retroversive pessary (Fig. 582); this apparatus is best adjusted with the aid of the speculum.[3]

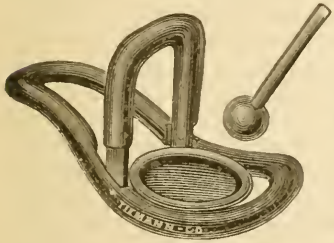


Fig. 852.

3. **Retroversion of the uterus**, occuring from succussion, is attended with severe symptoms; the patient falls to the ground and is unable to rise, experiences the severest pelvic pain, suffers from suppression of urine and fæces, and is often in such agony that the face is bathed with perspiration, and the pulse becomes weak and fluttering. The finger in the vagina discovers the cervix near the symphysis pubis, and a hard, round mass resting upon the rectum; if there is doubt in the diagnosis, use the uterine probe which will determine the direction of the axis. Place the patient on the left side, in a semi-prone position, as for a speculum examination; standing at the patient's back, and facing her head, introduce the index and middle fingers of the right hand, well lubricated, the palmar surfaces directed to the rectum; lift the uterus upon the inner surfaces of the fingers until it becomes erect, then their dorsal surfaces, or backs of the nails, are made to push the organ into position.

[1] T. G. Thomas. [2] O. White. [3] J. M. Sims.

If the uterus is irreducible, and requires more powerful means,[1] evacuate the bladder and rectum, loosen the clothing, have the patient kneel upon a hard surface, with the sternum as closely as possible in contact with the same plane; introduce the two fingers into the vagina, place them against the fundus, and direct the patient to fill the chest with air and expel it completely; at this moment, elevate the fundus, and restore it to its place. If this effort fail, elevate the hips still more, and repeat the attempt with the fingers in the rectum, instead of the vagina. If these methods fail, instruments should not be employed. In cases requiring less force, a repositor may be used (Fig. 583);[2] the stem is introduced to the fundus, and is then moved in the proper direction, by the slide, *a*, carrying the organ into position.

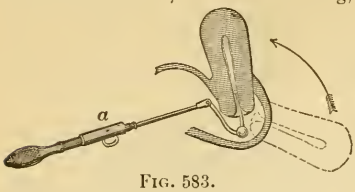


FIG. 583.

3. **Uterine polypus**[1] is a tumor covered by the mucous membrane of the uterus and attached to that organ by a pedicle. The symptoms are leucorrhœa, pain in the back and loins, menorrhagia, metrorrhagia, and hydrorrhœa; if the tumor is attached to the cervix it may be felt hanging from the canal or in the os uteri; if it is in the cavity, and small, its presence will not be detected by the sound, but there is often a copious flow of blood following the withdrawal of the instrument; if large, the uterus will be displaced and enlarged, and the cervix somewhat dilated. But no examination can be considered complete until the cervix has been fully dilated by tents and exploration has been made by touch. If a polypus exist in utero and the cervical canal be firmly closed, avoid immediate attempts at removal, unless the symptoms are grave; employ palliative measures until dilatation of the cervix, and, perhaps, expulsion into the vagina are effected; to facilitate expulsion, dilate by tents, or incise the walls of the cervix laterally, and use ergot steadily, either internally or hypodermically; if the os internum be fully dilated, and the tumor be in utero, seize it with a volsellum at its lowest extremity, and make a cautious, but rapid, attempt at its removal by torsion and traction, but lengthy manipulations in utero are always very hazardous; if it cannot be removed in this way, slide up along the wall of the tumor upon which steady traction is made, an écraseur or a pair of sharply-curved scissors, and sever the stem.

5. **Fibrous tumors of the uterus**[1] are submucous, interstitial, or sub-peritoneal. The more frequent symptoms, especially of the submucous variety, are menorrhagia, irritability of rectum and bladder, pain through the pelvis, uterine tenesmus, profuse leucorrhœa, dysmenorrhœa, pressure on the crural veins and vessels, watery discharge from uterus. Exploration should be conducted as follows:

[1] T. G. Thomas. [2] T. A. Emmet.

Place the patient on the back, with the thighs flexed; all constriction of the waist should be removed and the bladder and rectum emptied; depressing the uterus by the right hand placed over the hypogastrium, sweep the index finger of the other as high up as possible over the posterior wall, first by vaginal and then by rectal touch; lift the uterus with the fingers within, and force the tips of the fingers on the abdomen behind the fundus, and downwards over the posterior wall so as to approach the fingers in the pelvis, and thus explore this region; next, draw the cervix forwards with the finger in the vagina and pass the fingers external over the anterior wall, and explore; to examine the cavity, dilate the cervix fully by tents of sponge or sea-tangle, and, on their removal, depress the uterus and introduce the finger. The treatment of the vast majority of the submucous and and interstitial variety should be palliative; if the uterus is displaced, rectify its position and support it with a pessary; if the hæmorrhage is excessive, secure rest, give hæmostatics, or apply the tampon of cotton with solution of alum; or, if the bleeding continue, make deep incisions of the uterine canal on either side. Methods of treatment applicable to all uterine fibroids are absorption, excision, avulsion, enucleation, gastrotomy. Absorption has been effected by the persistent use of iodine and ergot; the former in large doses of the iodide of potassium, and the latter by hypodermic injection of the aqueous extract of ergot three parts, to glycerine seven and a half parts, and the same of water. Excision, avulsion, and enucleation require dilatation of the cervical canal, and projection into the uterine cavity. If a small tumor project it may be removed by the knife, scissors, or other cutting instrument; but if the écraseur can be used, it should be preferred; should the tumor be very large and fill the vagina, it may be drawn down by obstetric forceps; or it may be cut away, piece by piece, by knife or scissors, and removed, until its base is reached; or the galvano-cautery or écraseur may be used, portion after portion being removed. Avulsion is practiced with vulsellum forceps, firm traction with slight rotatory movement being made; if the tumor do not yield, introduce one hand into the vagina and two fingers into the uterus, and rupture the attachments of the growth. Enucleation is performed when the tumor is so much imbedded that other methods are unavailing; the cervical canal being previously fully dilated, place the patient on her back, upon a strong table, and, while an assistant firmly depresses the uterus, by means of a pair of scissors, guided by two fingers, cut into the capsule and into this opening pass the index finger, and fix the tumor; by means of scissors or a probe-pointed bistoury, make a crucial incision through the capsule as freely as circumstances will admit; now pass one hand cautiously into the vagina, and forcing the uterus towards

the vulva, with the other proceed to peel back the capsule and enucleate the mass. Or, a long crucial incision may be made over the presenting part of the tumor, the lips of the capsule separated by the finger, and the patient put upon the systematic use of ergot, in the hope that the body of the tumor may be expelled by uterine efforts. Gastrotomy, undertaken for the removal of sub-peritoneal tumors, is justifiable when the general decadence of the patient's strength makes it certain that a fatal issue must soon ensue. The operation is the same as ovariotomy, except that the pedicle of the tumor is the uterine neck or upper portion of the vagina; this part is tied with a double ligature in two portions.

6. **Cæsarean section**, laparo-hysterotomy, is undertaken to remove the child from the uterus in cases of extreme contraction of the pelvis, or of the sudden death of the mother. Operate antiseptically, if possible. First empty the bladder; make an incision in the median line from the navel, nearly to the pubes, and expose the uterus; while it is supported, laterally, incise the walls between the fundus and cervix; rupture the membranes, and remove the child by the feet; pass the hand between the anterior wall and membranes, and remove the placenta; prevent hæmorrhage from the uterus by pressure or cold, cleanse the cavity and vagina of all coagula with carbolized solutions; close the wound of the uterus by carbolized catgut sutures, cut short, and the abdominal wound with wire sutures.

As a substitute for this operation, dilatation of the cervix, section of the abdominal wall, and of the vagina, laparo-elytrotomy, has been recommended,[1] as involving less danger to the mother, because avoiding section of the peritoneum. In actual practice it is said to have given much better results than Cæsarean section.[2] The operator should be provided with a pocket-case of instruments, ether, dilators,[3] and thermo-cautery,[4] or, in place of it, ordinary cautery-irons. The patient having been etherized, should be placed upon a firm table, and the os fully dilated by dilators.[3] The abdominal wound should be made thus: with a bistoury cut through the abdominal muscles, the incision being carried from the spine of the pubis to the anterior superior spinous process of the ilium; separate the lips of the wound, and by two fingers lift the peritoneum, so that the vagino-uterine junction is reached; lift the vagina by a steel sound passed within it, and cut, and enlarge the opening by the fingers; lift the cervix into the right iliac fossa by the blunt hook, while the fundus is depressed in an opposite direction; then pass the right hand into the iliac fossa and introduce two fingers into the uterus, while the left hand, placed on the outer surface of the uterus, depresses the pelvic extremity of the fœtal ovoid; deliver the child by version, if the head or arm present; by extraction, if the breech do so. The placenta having been delivered, and the uterus caused to contract firmly, the iliac fossa should be cleansed by a stream of warm water, introduced through the abdominal wound, and escaping through the vagina; and if hæmorrhage exist, ligatures should be applied, if possible through the abdominal wound, to the bleeding vessels. Should this prove impossible, the vagina should be distended

[1] T. G. Thomas; A. J. Skene; H. J. Garrigues. [2] H. J. Garrigues.
[3] R. Barnes'. [4] Paquelin's.

by a large metallic speculum, and the lips of the abdominal wound being widely separated, the bleeding points touched by the actual cautery carried down from above. Should this fail, the uterus should be made to contract firmly by ergot, and both vagina and iliac fossa be thoroughly tamponed with cotton soaked in water and squeezed, but free from any styptic. Then a broad band of adhesive plaster and a compress should be applied over the lower portion of the abdomen. Should no undue hæmorrhage occur, the abdominal wound should be closed by interrupted silver sutures; the vagina should be syringed out every five hours with warm carbolized water, the nozzle of the syringe being carried through the vaginal opening, and the fluid forced out through that in the abdomen. The patient should be kept perfectly quiet, nourished by milk and animal broths, and kept free from pain by opium.

7. **Cancer of the uterus** is, in at least half of the cases, in the form of an epithelioma; it originates from the mucous lining of the cervix or from the vaginal portion, and may give rise to very extensive lesions in the uterus, and may lay open the bladder, rectum, or peritoneal cavity.[1] The symptoms[2] are pain through the pelvis, tenderness upon movement or coition, menorrhagia, ichorous and fetid leucorrhœa, hydrorrhœa, dark and grumous discharge, constitutional debility, pallor and cachectic facies, fistulæ. The touch detects, before ulceration, a hard and nodular tumor, which is not characteristic, but after ulceration the finger discovers the walls of a deep and ragged ulcer, covered with a crumbling mass which readily bleeds. The treatment is to secure cleanliness by tepid vaginal injections of antiseptics and astringents, nourishing diet, anodynes, removal by means of the electro-cautery, if possible; if adhesions render removal impossible, practice partial removal or destruction by galvano-cautery, the scissors, scoop, or curette, or by actual cautery, fuming nitric acid, or anhydrous sulphate of zinc. Caustics carefully applied to the ulcerated surface, often give great relief by arresting the destructive process and diminishing the discharges.

CHAPTER LV.

THE VAGINA.

THE vagina is a membranous and dilatable tube, extending from the vulva to the uterus, the neck of which it embraces; it rests below and behind, on the rectum, supports the bladder and urethra in front, and is enclosed between the levatores ani muscles.[3]

1. **Exploration of the vagina**[2] is made with the fingers and the speculum.

(1.) If the fingers are used, place the patient on the back, with the legs flexed and hips near the edge of the table; the index finger introduced will determine

[1] E. Rindfleisch. [2] T. G. Thomas. [3] Quain's Anatomy.

the capacity of the vagina, the existence of growths, the position of the cervix uteri; abdominal palpation should always be combined with the vaginal touch; if more extensive examination is required, two fingers may be introduced, or even the whole hand, but in this case anæsthesia is generally necessary, and the greatest caution should be exercised; to explore the posterior region, turn the patient on the left side. (2.) The speculum permits of visual examination; this instrument may be (*a*) cylindrical, and of this form none compare in elegance, cleanliness, and utility with the glass tube, coated with quicksilver, covered with rubber, and thoroughly varnished (Fig. 584); (*b*) bivalve (Fig. 585) and quadrivalve (Fig. 586); (*c*) single valve[1] (Fig. 587). The best position for the patient in the use of the former specula is on the back, as already explained; first depress the perineum with the tip of the conical speculum, well lubricated with soap, oil, or vaseline, and then carry it up to the cervix; insert the valvular instrument closed, and expand it when in position; on removal avoid catching the mucous membrane between the blades. In the use of the single valve,[1] place the patient in a position between that on the back and on the face, the left arm drawn behind so as to let her rest on the left side of the chest, and the right leg so flexed as to let the right knee lie just above the left; the speculum is gently introduced with the convexity towards the perineum.

Fig. 584.

Fig. 585.

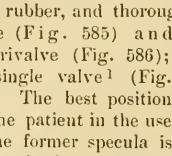


Fig. 586.

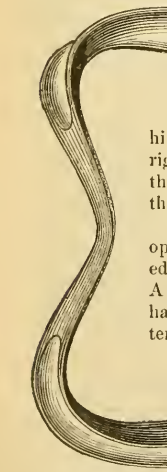


Fig. 587.[3]

This instrument may be made stationary, and thus enable the operator to both expose the interior of the vagina and apply remedies.[2] It consists of the following parts, arranged for use thus: A brass clamp is attached to the edge of the table on the left-hand side of the operator; in this clamp is fastened a steel rod ten inches long; a brass slide moves freely up and down the rod and also revolves upon it, being made fast at any point by a screw; in the upper part of this slide is a second screw passing through a slot in the arm; the arm is also of brass and terminates in a curve or hook, against which rests the speculum blade not in use.

In the practice of gynecology a table[4] properly arranged, with convenient drawers for instruments, is an excellent substitute for the unsightly, often ill-adapted and expensive chairs that are commonly used. The patient is easily and comfortably placed in the semi-prone position (Fig. 588),[1] or on the back, while every needed appliance is at hand.

2. **Vaginismus**[1] is an excessive hyperæsthesia of the vulvar outlet associated with such involuntary spasmodic contraction of the

[1] J. M. Sims. [2] J. B. Hunter. [3] G. Tiemann & Co. [4] J. R. Chadwick.

sphincter vaginæ as to prevent coition; violent spasmodic action is produced by the gentlest touch, as of a camel's hair pencil or fine feather; though all parts of the vaginal outlet are sensitive, it is greatest at the fourchette where the hymen projects upwards. It may be associated with and depend upon inflammation and thicken-

FIG. 588.[1]

ing of the hymen, excoriations, fissures, neuromata, caruncle of the meatus. The general treatment must aim to remove all conditions which are found to cause or aggravate the spasm.

Secure complete sexual abstinence, and for three or four days direct a tepid sitz bath, night and morning; warm local bathing, with lead water; freedom from friction by motion; then apply arg. nit. 10 to 20 grs. to ℥i. of water to the parts; after eight days of this treatment, insert vaginal suppositories of ext. belladonna and cocoa-butter behind the hymen, daily, for two or three weeks; then commence dilatation with graduated glass specula, allowing them to remain from one half to one hour, and increasing their frequency.[2] Other useful applications are iodiform;[3] ointments containing atropine, 2 grs. to an ounce of lard.[4] If these remedies are not successful, operative measures are necessary.

Forcible dilatation may first be employed:[5] Give an anæsthetic, and proceed to distend the ostium vaginæ with the thumbs, in the same manner as the sphincter ani is dilated (Fig. 390). Or, use the trivalve or quadrivalve speculum for distention.[6] If spasm persist,

[1] Codman & Shurtleff. [2] Scanzoni. [3] Tarnier. [4] E. R. Peaslee.
[5] E. J. Tilt. [6] T. G. Thomas.

give an anæsthetic and excise the remains of the hymen with scissors,[1] and incise the perineal body exactly as it is torn in parturition;[2] introduce the dilating speculum or plug, and wear it for a week, changing it daily for cleanliness; then employ copious vaginal injections of warm water, twice daily.

3. **Vesico-vaginal fistula,**[1] following parturition, is an opening due to sloughing into the bladder, resulting from delay in delivery after impaction has taken place. The only remedy is closure by suture. The secret of success in this operation lies in a course of preparatory treatment by which the hypertrophied and indurated edges of the fistula have recovered a natural color and healthiness. The course of treatment may require many weeks. First, the deposits upon the surfaces of the fistula must be removed by means of a soft sponge; then the raw surface must be brushed over with a weak solution of nitrate of silver about every fifth day; copious

Fig. 589.

warm water injections to the vagina must be used several times daily; and warm sitz baths are useful. The patient being in proper condition, place her on the table, (Fig. 588) on her left side, the knees flexed on the abdomen, the body well rolled over on the chest, the left arm turned up over the back, and the head elevated as little as possible. Having decided on the direction for closing the fistula, scarify its edges by seizing with a tenaculum (Fig. 590) or forceps (Fig. 589) the most depending point, and with scissors of proper curve (Fig. 591) remove the inner edge in a continuous strip.

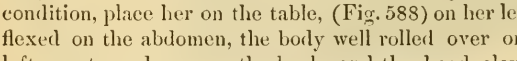


Fig. 590.[3]

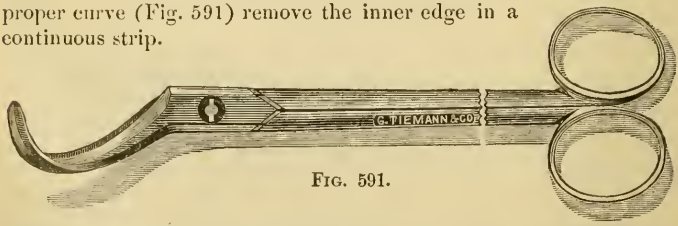


Fig. 591.

It requires but little practice to make this, in most cases, continuous around the entire fistula to the starting point; if the denuded portion is not of sufficient width more should be removed; just outside of it the scarification should extend as near the mucous membrane of the bladder as possible without involving it.[2]

[1] J. M. Sims. [2] T. G. Thomas. [3] G. Tiemann & Co.

The best method of securing the edges of the fistula is by the simple interrupted suture. The needle should be armed with a short silk loop, tied with a half knot at the eye, and the wire should be attached.

The needles should be from one half to three quarters of an inch in length, round, with a slight curve near the point, thickest at the eye and countersunk to receive the thread; this needle makes a punctured wound which the wire perfectly fills. The needle should be inserted with suitable forceps (Fig. 592).[1]

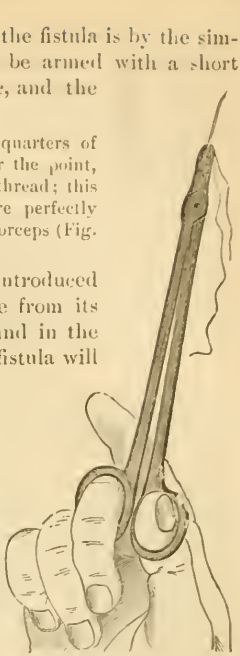


Fig. 592.

The point of the tenaculum should be introduced towards the fistula at a convenient distance from its vaginal edge, then by a rotation of the hand in the opposite direction the bladder edge of the fistula will be turned out; introduce the needle, held in the forceps, behind the tenaculum, bringing its point out just at the bladder surface, and while still grasping it with the forceps withdraw the tenaculum, pass its hook over the point of the needle to make counter pressure, while it is advanced as far as the forceps will allow; then seize the exposed portion of the needle and draw it entirely through; seize the edge on the opposite side with the tenaculum, in the same manner and introduce the needle at a corresponding point near the bladder surface. As a rule, four or five sutures should be applied to the inch (Fig. 593), and one or more should be passed at each extremity. As each suture is introduced, follow it at once with the wire, for the silk soon becomes weakened after being saturated with the blood and urine. It is generally most convenient to secure first the suture nearest the outlet of the vagina; make sufficient traction to bring the edges of the fistula together and cut off the excess of wire (Fig. 594); introduce the loop within the slit of the shield (Fig. 595), and, with the twisting forceps, twist the loop until the edges of the wound are approxi-

Fig. 593.

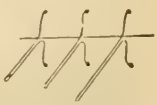


Fig. 594.

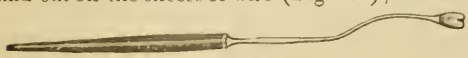


Fig. 595.[2]

[1] J. M. Sims.

[2] G. Tiemann & Co.

mated, but not strangulated; cut each suture with scissors (Fig. 596) half an inch from the wound, and turn the ends flatwise by drawing them over the hook. The sigmoid catheter (Fig. 597) is now introduced into the bladder, and rest upon the back, secured with quiet; the vagina must be syringed with soaped-water, daily, and simple diet enforced; the sutures should be removed about the tenth day.

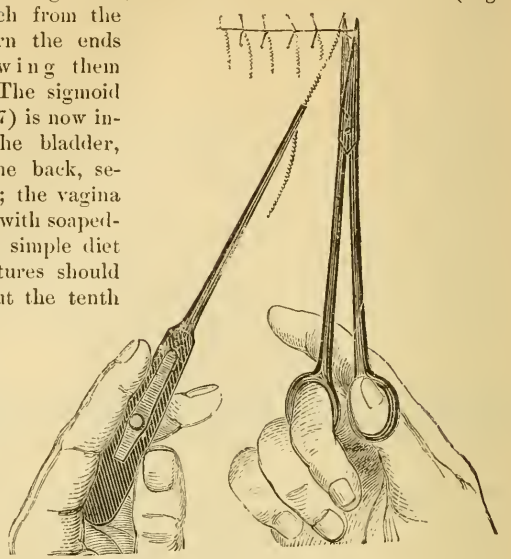


Fig. 596.

4. **Tumors of the vagina,**[1] solid and non-malignant, are rare; they are usually fibroids or fibro-myomata, rarely pure sarcomata; they may spring from any part of the vagina, appear at any age, grow slowly and without inconvenience. Their removal is attended with hæmorrhage, and hence the galvano-caustic, or écraseur,[3] is required.

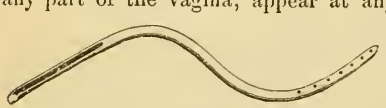


Fig. 597.[2]

CHAPTER LVI.

THE VULVA.

The vulva is a general term which includes all the external parts of the generative organs of the female.[4]

1. **Adhesion of the labia,**[5] the most common deformity met with, exists when the parts adhere together just at the nymphæ, or in front of them, close to the meatus urethræ; it appears as a grayish-looking septum, usually complete. The treatment should be immediate rupture, for if the membrane be allowed to remain it may

[1] Neugebauer. [2] G. Tiemann & Co. [3] J. M. Sims. [4] Quain's Anat.
[5] T. Holmes; A. Johnson.

become thicker and require dissection; after rupture the parts must be maintained well opened.

2. **Imperforate hymen**[1] may be recognized in the child, but generally it is not discovered until puberty. It appears as a membrane stretched across a well-formed vagina, within an inch or two of the labia, and more or less thick and unyielding. An effort should always be made to determine its thickness; and also whether the uterus is present, by examining as to the amount of space between the bladder and rectum;[2] if the space is slight, there is reason to believe that there is no uterus, and an operation may be deferred. But an early operation is much safer than one undertaken after menstruation has begun, and should be performed, if necessary. In children, the membrane may be readily ruptured; but at puberty the operation is attended by much danger to life.

In a very considerable proportion of cases, fatal peritonitis ensues in a few days, due, apparently, to the escape of menstrual fluid through the Fallopian tubes.[3]

Operate thus: place the patient on the back, with the thighs flexed; the exact position of the centre of the vagina above being made out, direct the patient to force down; when the occluding structure is distended, introduce a bistoury into its centre and enlarge the opening so as to admit the finger which will act as a director in making free crucial incisions; if there is a redundancy of membrane, dissect away part of it; care must be taken, for a week or two, to prevent contraction.

3. **Thrombus**, blood-clot, resulting from injury, forms in the labia; in time it undergoes softening, and an abscess results. The early treatment should be cold, but when suppuration occurs poultices must be applied, and the abscess opened when fully formed.

4. **Hypertrophies of the labia** commence usually in inflammatory œdema produced by the irritation of gonorrheal discharge or mucous tubercle; they consist only of hypertrophied cutaneous tissue, and when large increase in consequence of the mechanical impediments to the circulation. They should be removed early, and, owing to the tendency to excessive hæmorrhage, the base should be transfixed by harelip pins with twisted ligatures, after all bleeding vessels have been ligated.

5. **Epithelioma**[1] is the chief form of malignant disease of these parts; it appears as an irregular, undermined, indurated edge, an unhealthy gray surface, and a tendency to the production of warty granulations; the prognosis is very unfavorable, owing to the ten-

[1] J. Hutchinson. [2] T. Holmes. [3] Bernutz.

dency to rapid absorption. Removal by the knife or caustics is the only remedy.

6. **Laceration of the vulva and perineum** occurs during the last act of labor, and may be due to (1) anatomical conformations, as a too straight sacrum, a too sharp curve forward of the vagina, extreme smallness of vulva; (2) excessive size of the head of the child; (3) peculiarities of labor, as face presentations, incomplete or excessive flexion, too rapid or too slow.[1] The extent of laceration may vary from a slight fissure to complete division of the perineum and sphincter ani.[2]

By laceration of the perineum the ischio-perineal ligaments are divided, and then the transverse perinei muscles and other attachments draw the sides of the vaginal outlet apart; the connective tissue of the pelvis can therefore no longer exercise the same sustaining power, nor that little in the same direction as heretofore, so that the canal now remains patulous; there remains no support to the uterus while the woman is in the upright position, except through the connective tissue and the utero-sacral ligaments; as she stands erect, in this condition, a perpendicular line, from the front of the sphincter ani, would pass through the posterior lip of the uterus, or even behind it; the uterus is thus suspended over a constantly dilated and relaxed cavity, and with this state of things, before a very long period complete prolapse of the uterus will take take place.[3] In the normal relation of parts, it is seen that the perineum and recto-vesical septum sustain the uterus with great firmness (Fig. 598).[4]

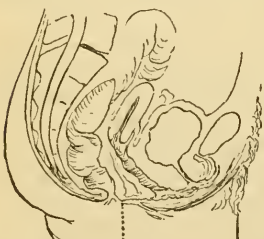


Fig. 598.

The laceration may even involve only the vaginal surface without extending through to the skin, and this is done by splitting through a fold of vaginal tissue which may be found in advance of the child's head just before birth; this lesion seems to extend deep enough to divide the central attachment of the ischio-perineal ligaments, with the effect of leaving the vaginal outlet flaccid and depriving it of its proper support. The importance of having the perineum intact, and its influence on the healthy condition of the nervous system, is not fully appreciated; when extensively lacerated, and prolapse occurs, it is easy to recognize an obvious cause of suffering; but cases are met with complicated by nervous disturbances, due to the existence of this lesion, without prolapse; this condition will sometimes be accompanied by a general irritability which cannot be traced to any other local cause, and is only relieved by restoring the perineum; there are instances in which the existence of even a scar on the perineum excited so

[1] B. F. Barker. [2] I. B. Brown. [3] T. A. Emmet. [4] Savage.

much reflex irritation as to entirely change the disposition of the woman, and yet she was not conscious of any local difficulty.[1]

Whenever the perineum has been lacerated so that the proper degree of support to the vaginal walls is no longer exerted, there can be no doubt as to the necessity for an operation to restore the parts to their original condition; there are cases, however, where a doubt may remain even after a careful examination; but if, after the occurrence of the accident, the vagina becomes a patulous canal, so that the air enters and is displaced from the passage with every movement of the body, the operation is required.[1]

It is yet a mooted question, how soon after the injury the operation should be performed; but when the laceration has extended through the sphincter, the parts should be brought together immediately after delivery, in every instance when it is possible to do so.

It is true that the lochial discharge is poisonous to a healing surface, yet a large number of these operations would be successful with a little additional care: the operation would be comparatively a simple one, and it would be unnecessary to pass the suture behind the muscle; something would be gained in every case, and support would be given to the uterus, for a while at least, until it had become somewhat reduced in size, and time gained for the overstretched vaginal tissues to recover in part their tone; a week even thus gained, in giving a proper support to the parts, may be the means of saving the patient from the necessity of undergoing treatment for months; this she may be spared, even if the operation itself should fail; if the condition of the patient, after delivery, is too critical to admit of the additional operation for bringing together the edges of an extensive laceration through the septum, it is advisable to introduce the deep perineal sutures, to include as much of the septum beyond the muscle as is possible; these sutures can be rapidly introduced, and without any special care beyond including a liberal amount of tissue; if a union of the perineum is thus gained, with a portion of the septum beyond the sphincter, but a small recto-vaginal fistula will remain; this may prove a discomfort, but its closure may be safely deferred; this little opening may be closed by dividing the perineum and sphincter ani by means of a pair of scissors, which permits the edges of the opening to be thoroughly denuded, a procedure otherwise very difficult; the parts can then be brought together and treated in every respect as if it were a case of laceration in which the surfaces had just been freshened [1] Or, the opening may be closed after denuding the edges, by passing the sutures around the fistula from the perineum; with the finger in the rectum as a guide, a suture is passed so as to close the edge on the rectal side, and another above for the vaginal border; the lower suture includes so much of the sphincter ani muscle, that its action in the upper part is controlled; by this means the fistula closes, a result which is almost impossible to be obtained under ordinary circumstances, since the outer fibres of the muscle form one side of the fistulous opening.[1]

When an operation cannot be resorted to immediately after the injury, the knees should be kept tied together, the urine properly drawn, and the greatest care given, by cleanliness, to free the parts from irritation; at the reception of the injury, the rent through the

[1] T. A. Emmet.

septum is more extensive than after the edges have cicatrized, therefore, if proper care be taken, by frequent injections of tepid water, to keep the parts free from irritating discharges, the edges will unite to within a short distance of the sphincter; before the patient is allowed to assume the upright position, some mechanical support must be resorted to for the purpose of lifting the uterus from the floor of the pelvis, and also to keep the organ partially anteverted, so that there may be no prolapse of the vaginal walls; after she has recovered her strength, if the child has been still-born, the operation should be performed without further delay; for the welfare of the child, if she be nursing, the operation should be deferred until it is old enough to be weaned with safety; but, at the same time, we must take into consideration the condition of the mother, as to how long she may be safely subjected to the delay, with the uterus well supported.[1]

If the sphincter ani is not involved, proceed as follows:[1] Place the patient on a narrow table, and administer the anæsthetic; now flex both legs on the abdomen, to be thus held by an assistant after the body of the patient has been drawn down to the edge of the table; in separating the labia, the fingers of one assistant must be placed directly opposite those of the other; this is necessary, for if not on the same line, or if unequal traction be made, it would be difficult to avoid denuding the side of one labium higher than that of the other. Commence the operation by removing the mucous membrane at the most dependent portion, and advance from below upwards, and thus avoid the flow of blood over the surface to be removed.

The mucous membrane is caught up on the point of a tenaculum, and with a pair of properly curved scissors it should be removed in a horizontal strip running from side to side; if the operator is ambidextrous, the whole surface may be removed in one continuous strip; by using a pair of scissors with a different curve to turn the point at one labium, we can extend the line back again upon the posterior wall of the vagina, and from there to the opposite labium, and then going over the same course again just above the preceding one (Fig. 601).

Determine the extent to which the denudation is to be carried on the posterior wall, and mark it by removing, as a guide, a small portion of tissue from the median line; the advantage of the scissors in this operation cannot be questioned, for with the utmost dexterity and quickness, the parts cannot be freshened and brought together without a great loss of blood, and the amount of bleeding is less from the use of scissors, and with them the parts can be denuded in a much shorter time than with the knife.

Use a thick, straight sewing needle, from an inch and a half to two inches in length, with a large eye for introducing the silk loop,

[1] T. A. Emmet.

to which the wire is to be afterwards attached before being drawn through; the index finger must be passed into the rectum to appreciate the course and facilitate the passage of the needle, and, at the same time, it will protect the posterior wall of the bowel from becoming transfixed; as the tissues of the recto-vaginal septum are thus lifted up on the point of the finger the course to be followed by the needle becomes nearly straight. The central letter C (Fig. 599) is at the crest of the rectocele; the surface has been denuded from the edge of the sphincter ani muscle up each labium to the remains of the carunculæ, and across on the posterior wall of the vagina to the extent of the rectocele. Introduce the first suture nearest to the edge of the anus, and its course through the recto-vaginal septum is indicated by the dotted line. The same explanation in regard to their course is applicable to the other numbered sutures. The course of the suture D is shown on its exit, from behind one labium, to enter at D on the upper edge of the denuded surface over the posterior wall of the vagina. This is essentially the last suture introduced to secure this surface, and does not include more than an inch before it passes to the opposite labium. The course of the uppermost suture, C, is through the labium, just in line with the limit of the freshened surface. It is then made to catch up a small portion of the vaginal tissue at C, beyond the denuded surface on the recto-vaginal wall, when it also passes to the opposite labium. Leave each twisted suture about three inches in length, and when the operation has been completed, secure the ends of all of these together, like the radii of an open fan; these ends may be bound together by slipping over them a short section of rubber tubing. The patient must be kept in bed with her knees tied together and a soft pad between them; the urine should be drawn with care, to prevent it from running over the healing surfaces; this can best be done by flexing the legs over the abdomen, as at the time of the operation, but without removing the bandage from the knees; then, with a strip of soft cloth covering the index finger of the left hand, the parts may be protected by placing this beneath the urethra as the catheter is withdrawn. The additional precaution should also be taken to close the end of the instrument by keeping the finger over

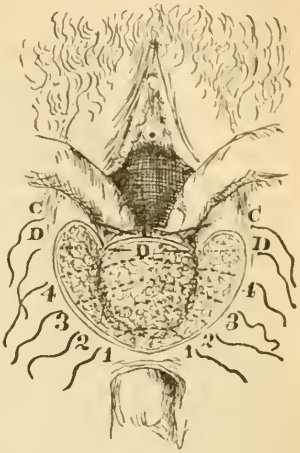


FIG. 599.

it. Should the urethra become irritable, or circumstances occur in which the catheter cannot be employed, it will be necessary to observe more than the usual cleanliness; after the bladder has been emptied, and before removing the bed-pan, the nurse must throw a pint or more of tepid water into the vagina. The nozzle of the syringe should be carefully introduced close to the urethra, and during the administration of the injection it is to be held in this position so as not to come in contact with the line of union. Opium should not be used in any form, unless the necessity be very great, and even then it is well to seek some substitute for it. The position of the patient may be changed from the back to either side without injury to the sutures, so long as the limbs are kept together. The parts will have become sufficiently healed by the seventh day for the removal of the sutures; no advantage is to be gained by leaving them for a longer time, but, on the contrary, there will be risk from inflammation following some accidental injury; to remove the sutures, it will be necessary to place the patient on a table, and on her back, with the feet drawn up; as it would not be advisable to separate the parts to bring the loops into view, it will be necessary to trust somewhat to the sense of touch; first remove the piece of tubing by cutting through the mass of sutures, which will free them all; then the lowest one may be grasped by a pair of forceps and gently turned to the right side, while the blades of a pair of sharp-pointed scissors are passed down along the left side of the suture in search of the loop. The parts can be supported and also protected by an assistant pressing or holding the labia together until all the sutures have been withdrawn. For a week after the removal of the sutures, the limbs should remain bound together, then the bandage may be thrown aside, and only used at night for a short time longer. It should be the rule that the patient be not allowed to assume the upright position for two weeks.

7. **Laceration through the sphincter ani**[1] is but an extension of the laceration of the perineum. It is, however, without any necessary bearing on the study of prolapse, since advice is generally sought for early, and the injury repaired before sufficient time has elapsed for the case to become thus complicated. Both conditions are but different degrees of the same injury, and the same operation also, varying only in detail, is required for the relief of both. The necessary dissection of the surfaces about to be united must be made as before, and when completed the wound will appear as represented (Fig. 601).[2]

When the perineum and the muscular ring forming the sphincter ani have been lacerated, a gaping triangular opening is left; the base of this opening

[1] T. A. Emmet. [2] G. G. Bantock.

would be formed by the lacerated muscle and the apex by the limit of the laceration through the recto vaginal septum: gradually the fibres which formed the inner surface of the circle, when the muscle was in its integrity, will have shortened more than those on the outer margin which remain attached to the neighboring tissues: the diagram (Fig. 600) shows the corners rounded off, and the muscular fibre under the mucous membrane of the rectum contracted more than any other portion; a convex surface is presented by the shortening of the inner fibres from the dotted outline, representing a parallelogram, which was the original shape of the muscle just after it was ruptured. After the edges of the muscle have been properly freshened, the most important step in the operation will be the manner of introducing the first suture, in its relation to the edges of the divided muscle. If the first suture be entered on the line a little outside of A B (Fig. 600), and at the point which would seem the most appropriate, but a small portion of the muscle could be approximated. Fig. 602 exhibits the condition of the parts, when they have been thus secured by a suture entered from A B, with incontinence as the consequence. Introduce, however, the suture at some distance behind the edge of the muscle, as the points C D (Fig. 600), and a different result will be obtained; a glance at Fig. 603 will show that, on securing the sutures, the divided edges of the sphincter will be turned up and brought in perfect apposition: When the suture is passed from behind the edges of the muscle and around the laceration, in the recto-vaginal septum, the edges of the muscle must be turned up on tightening.

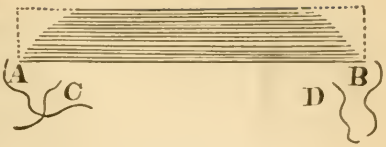


Fig. 600.

Fig. 601.

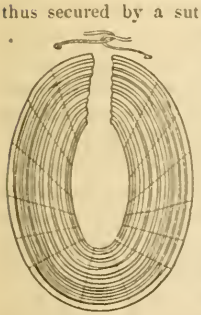


Fig. 602.

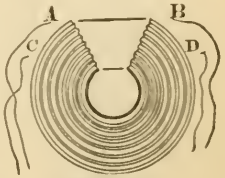


Fig. 603.

The necessary position of the patient for the operation, with all other details, are essentially the same as described for closing a laceration of the perineum. The surfaces which have been lacerated, and are again to be freshened, are generally well mapped out by a slight cicatricial glaze. Under ordinary circumstances, unless sloughing has occurred, there can be but little difficulty in determining the extent. As the edges of the laceration through the septum have to be freshened with care, it is essential to commence the denuding from the most depending point, and by this means escape the annoyance of blood flowing over the parts.

If we examine carefully the extremities of the lacerated muscle, we shall find a slight pit or depression at each end, which has been caused by the contraction of a portion of its fibres. It is necessary to freshen these surfaces, for by so doing we denude the ends of the muscle along the spaces between the dotted angles, shown in Fig. 600. At the commencement of the operation a portion of the tissues at one of these points must be seized with a tenaculum and with a pair of scissors removed, together with a narrow strip entirely around the laceration to the opposite end of the muscle. This strip must be removed as close to the edge of the rectal mucous membrane as can be done without wounding it. Whenever the edges of the laceration, in the recto-vaginal septum, are found terminating in a thin beveled edge, it will be necessary to gain the needed width by removing a sufficient portion of the vaginal mucous membrane.

The needle is to be introduced behind the edge of the muscle to the left, at the point D, Fig. 600. It is then made to sweep around the angle of the laceration in the septum to the point of exit at C, and this is done by gradually rotating the forceps with a movement of the wrist. As in laceration of the perineum, it is necessary that the index finger of the left hand be introduced into the rectum to serve as a guide. As the point of the needle punctures the skin in its exit, the finger may be withdrawn from the rectum to aid the passage of the needle. This can be done by the counter pressure of a blunt hook, or by sliding back the tissues sufficiently with the fingers, for the needle to be seized by the forceps and drawn through.

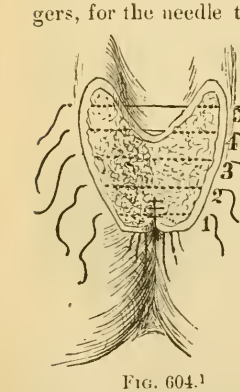


FIG. 604.[1]

The second suture is to be introduced just outside of the end of the muscle, and in the same plane with the divided rectal edge of the laceration. The third suture is to secure the vaginal edge of the laceration. It should be made to include the tissues liberally, and to sweep around the angle of the laceration at some distance beyond the course of the first and second suture, this is necessary, since this suture is the one most liable to cut through the recto-vaginal septum and leave a fistula. The other sutures are to be introduced as in a case of simple laceration of the perineum (Fig. 604). It is necessary to secure first the lowest suture, C D (Fig. 600). This is done by seizing the ends of the wire at a proper distance, so that the fingers may be used to slide the tissues firmly down on the suture, as moderate traction on the wire, is made at the same time with the hands. The suture is then secured, without relaxing the traction, by several half turns made on reversing the position of the hands from one side to the other. Each suture is thus in turn secured from below upward.

[1] G. C. Bantock.

The parts should be just brought in apposition, and no more, for in a few hours there will be sufficient swelling to force the tissues in close contact. The after-treatment is the same as that given above.

CHAPTER LVII.

THE MAMMARY GLANDS.

These glands, the organs of lactation in the female, are accessory parts of the reproductive system; when fully developed, they form, with the integuments and a considerable quantity of fat, two rounded eminences, the breasts, placed on each side on the front of the thorax; the base of the gland is nearly circular, flattened, or slightly concave, its largest diameter being directed upwards and outwards; it rests upon the pectoral muscle, to which it is connected by a layer of areolar tissue.[1]

1. **Inflammation of the breast,**[2] mastitis, may occur in three forms. (1.) The subcutaneous connective tissue may alone be affected; this form is often caused by bruising or irritation, as in rude attempts to use a breast pump, the symptoms and appearances being those of phlegmonous inflammation. The treatment, at first, must be painting with iodine, avoidance of rubbing, and of bruising, while nursing, aconite if the fever is high; anodynes to relieve pain; if suppuration occur, apply hot poultices, or cloths soaked in hot water and covered by oiled silk; evacuate pus, when detected, avoiding the areolæ, to prevent a cicatrix which would retract the nipple. (2.) The gland structure may inflame from lacteal obstruction or engorgement; it is marked by a nodulated induration, exquisitely tender, and very painful, rendering nursing distressing; the constitutional symptoms depend upon the individual; if she is robust, the fever is high and the course of the disease rapid, but if she is feeble, the fever is less and the course chronic. The early local treatment is relief to the engorgement by gently rubbing the lump with the fingers lubricated with olive oil until the mass disappears, avoidance of nursing and the relief of the breast by artificial means, supporting the breast by a broad bandage passed under it and around the neck; ext. belladonna, well rubbed in, to relieve pain, relax tissues, and diminish the secretion of milk; if suppuration is evident hot poultices must be applied, and the abscess opened when fluctuation is distinct; too early incision is liable to involve the milk tubes. If the fever is high, give aconite to the robust, and saline laxatives and quinine, to the more feeble; opium, as Dover or Tully powder,

[1] Quain's Anatomy. [2] B. F. Barker.

or the bromides, are always useful. (3). The inflammation may attack the subglandular connective tissue; the breast is greatly enlarged and heavy, but smooth, and not markedly tender; there are irregular chills and fever, with intervals of perspiration. The treatment is avoidance of bruising, as rubbing the breast, but nursing must be continued; support of the gland by the bandage; poulticing at the point where pus is forming; evacuation of pus by puncture without wounding the gland structure; the general treatment is the same as that given in the other forms of inflammation.

2. **Abscess of the breast** is liable to remain in a chronic form after the glandular and subglandular varieties, which are sources of great annoyance and continued ill health.

Their chronicity depends upon the fact that the abscess-cavities have no direct outlet for their contents; the escape from existing sinuses is chiefly the overflow; from time to time the corrosive secretion opens new and more direct outlets, and not unfrequently a single abscess is found to have several sinuses, or cicatrices of sinuses which have healed as new openings formed.

The treatment by incision, to lay open the abscess, is unnecessarily severe, and is often followed by deep cicatrices which destroy the function of portions of the breast; systematic strapping is far more useful, for by compressing the abscess-walls so as to force out the contents and place the opposing surfaces in apposition, union often promptly follows, and the cure is complete.

The straps should be cut sufficiently long to pass from the opposite shoulder, under the breast to the point of starting, and in width about two inches; having the breast firmly raised, apply the end of the strap over the opposite shoulder, and pass it under the breast and axilla, and over the back to the place of departure, allowing the ends to overlap (Fig. 605). Each successive strap should overlap the preceding towards the nipple, until the required compression or support is attained.

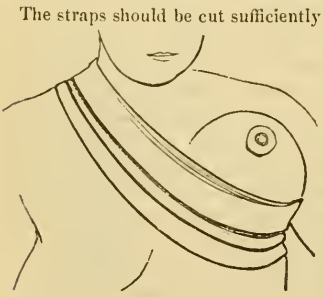


Fig. 605.

A still more simple and effective method is pressure with the compressed sponge, as follows:[1] —

Select a soft sponge, larger than the breast, cup-shaped, and three or four inches in thickness when wet; wash it and place it between two boards under a weight of fifty pounds; in a few hours it will be dry and reduced to the thickness of the hand; place it upon the breast, the cup being over the nipple, and bind it firmly in position with repeated turns of the bandage around the body and over the opposite shoulder; if the sponge is too harsh, apply a layer of lint or soft cloth first to the breast; leave a small portion of sponge projecting above

[1] J. P. Batchelder.

the highest turn of the bandage; now apply warm water to this point of the sponge and continue until the entire sponge becomes saturated under the bandages; the swelling of the sponge evacuates by the gentlest and most uniform pressure the cavity, presses the walls together and maintains them till union takes place; the water must be reapplied as often as the sponge becomes dry; the dressings must be renewed on the third day, unless the abscess has healed.

3. **The nipple and areola**[1] are liable to be affected in women forty years and upwards, with a chronic affection of the skin, which often precedes cancer of the deeper parts of the gland; it appears as a florid, intensely red, raw surface, very finely granular, as if nearly the whole thickness of the epidermis were removed, like the surface of very acute diffuse eczema, or an acute balanitis; there is always a copious, clear, yellowish, viscid exudation; the sensations are commonly tingling, itching, and burning, but the general health is unaffected. The cancerous growth has always appeared within two years, not in the skin, but deeply in the glands. The treatment by ordinary remedies has proved unavailing; removal of the breast is suggested as the more judicious procedure.

4. **Tumors of the breast**[2] may spring from the epithelial elements of the gland, or from its connective tissue; the former embraces simple hypertrophy, adenoma, soft and hard cancer, and the latter sarcoma, fibroma, and myxoma. Most of the tumors may develop cysts as they increase in size. The recognized treatment is removal, and the success of the operation, as well as the extent of the incision, must depend upon the nature of the growth.

(1.) **Non-malignant tumors of the breast**[3] more often occur in women under forty; they are covered with healthy skin, except in the ulcerated stage of the sarcomata, and the skin even then does not appear infiltrated; they are somewhat nodulated, not very hard, occasionally partially elastic, movable, and non-adherent; the nipple is rarely retracted and the superficial veins are not markedly dilated; there is seldom much pain, except in the case of the irritable tumor, and then continuous and of a neuralgic character: the neighboring lymphatic glands are not involved; there is no tendency to multiplication in internal organs, and, therefore, no cachexia; the tumor grows slowly and rarely recurs when thoroughly excised, except sarcomata, which grow rapidly and are very apt to recur.

(2.) **Scirrhus**[3] is seldom met with in persons under forty; it originates as a small nodule, of stony hardness, and soon becomes fixed and adherent to subjacent tissues, being evidently infiltrated among the tissues in which it is developed; the skin becomes widely involved, having a peculiar pitted or dimpled appearance, from the shortening of various subcutaneous fibres; in an extreme degree the pitting gives the whole breast a brawny or lardaceous appearance; the nipple is commonly retracted and the superficial veins dilated; the pain is severe, but not continuous, of a lancinating or electric character: the neighboring lymphatic glands, particularly those in the axilla and above the clavicle, become involved in the disease, which is often attended by a marked state of

[1] Sir J. Paget. [2] E. Rindfleisch. [3] J. Ashurst, Jr.

cachexia; the tumor usually grows pretty rapidly, is attended with ulceration, often of a peculiar character, and frequently recurs after apparently thorough removal.

5. **Extirpation of the breast**, in part or whole, is undertaken to remove growths. If the tumor is non-malignant, the incision should be limited to the growth, and care be taken to avoid injuring portions of the gland not involved in the disease. These incisions assume various forms, according to the size and condition of the tumor, but, as a rule, the skin should not be sacrificed unless it is diseased. If the skin is involved, the incisions should be so directed as to remove the affected portion, and preserve, in good condition, the other parts of the breast[1] (Figs. 606, 607).

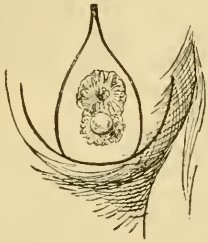


FIG. 606.

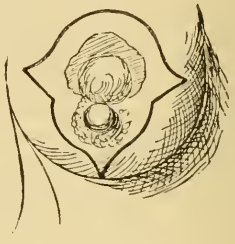


FIG. 607.

Malignant growths, on their first appearance in the breast, imperatively demand removal, for experience proves that life may thus be prolonged, a certain amount of immunity from bodily suffering and mental distress insured, and a chance of freedom from all local suffering given.[2]

The operation of removing the tumor, together with the breast, is always admissible when the health of the patient appears to be favorable to recovery from that operation, when the disease involves the tissues of the breast only, and when the axillary lymphatic glands are not involved.[2] It may also be undertaken with advantage when the disease has extended to the skin without infiltrating the cutaneous tissue to a wide extent, when ulceration has taken place, and even when the axillary lymphatic glands are distinctly enlarged.[2]

Removal may be effected by incision or by caustics. Incision is to be preferred when the tumor is movable and ulceration has not occurred. In making the dissection the immediate vicinity of the tumor must be scrupulously avoided. The shape of the tumor must determine the incision, but, in general, it should be in the direction of a line radiating from the nipple, as from a centre, the long axis inclining as much as possible downwards and outwards when the patient is recumbent.[2] If the skin is involved, two incisions will be

[1] P. C. Delagarde. [2] J. Birkett.

required to include the diseased portion; the lower must be made first to avoid the flow of blood. Operate as follows: The arm of the affected side being elevated to render the pectoral muscle tense, make the first incisions through the skin and connective tissue, in the form of an ellipse, or circle; separate the attachments of the tumor from its connections on all sides; in raising the tumor from its deep connections, commence at the extremity towards the axilla, expose the pectoral muscle, and dissect downwards and forwards towards the median line until the entire mass is removed. If there are enlarged glands towards or in the axilla, extend the incision and remove them, using the handle of the scalpel to avoid wounding vessels or nerves. During the dissection, control the hæmorrhage by pressure with dry sponges without stopping to ligate vessels. When the tumor is removed, ligatures or torsion should be applied to all bleeding vessels; the surface should be treated with carbolic solution, or zinci chlorid.;[1] then the margins of the wound should be adjusted with sutures, applied at every quarter inch, commencing in the centre. At the axillary angle an opening must be left for drainage, either by horse-hair, or a drain tube. The external dressings should be light and dry, the carbolized gauze or jute being preferable. It is desirable, in applying this part of the dressing, to make gentle but uniform pressure to bring the deep surfaces of the wound in accurate apposition with a view to immediate union[2]

The value of caustics in the treatment of cancer of the breast is very great, and they should always be preferred to the knife when ulceration has taken place, and the adhesions are deep or widespread. The most manageable and useful application is the anhydrous sulphate of zinc mixed with the strong sulphuric acid until it forms a thick paste.[3] This paste should be freely applied repeatedly to the open surface, and followed by poultices and carbolic washes until the entire mass is removed; cicatrization frequently follows the use of this caustic. Or, caustic arrows may be prepared by mixing a concentrated solution of chloride of zinc with flour until a firm plaster is formed; this mass should then be cut into arrow-shaped points; they are inserted by first thrusting the point of a sharp knife under the tumor and then pushing the sharp point of the arrow into the wound until the whole mass is lodged under the skin; repeat the insertion at intervals of an inch until the tumor is surrounded; apply poultices to hasten the sloughing and separation of the growth.

[1] C. De Morgan. [2] Sir J. Paget. [3] Sir J. Y. Simpson.

XI.

THE EXTREMITIES.

CHAPTER LVIII.

AMPUTATION.

An amputation is required to preserve life from the consequences of disease or injury, and is justifiable only when the question of recovery by other means is placed beyond all reasonable doubt, or the presence of an incurable disease is a source of such evil or discomfort as to render the loss of the limb desirable or beneficial to the patient.[1]

No operation is undertaken by the conscientious surgeon with so much reluctance and real pain, and with such a profound sense of personal responsibility.[2] And to the more indifferent operator an amputation frequently assumes an extreme importance by having all the circumstances attending the loss of a limb critically, and often savagely, reviewed in the courts.[3] These responsibilities can be properly met only by the most deliberate care in the management of every detail in each case, aided by the best available counsel. The final judgment as to the necessity of an amputation in any given case must be sustained by the latest surgical experience, for an amputation that would formerly have been justified would now be repudiated by the best authority, and the operator justly charged with ignorance and unskillfulness.[3]

1. **The time of the operation** must be fixed with due regard to the cause which necessitates the amputation, and the condition of the patient. There is a time when interference must be avoided, not less than courted, but the limits of the two periods are not always well defined, and must be left to the judgment of the surgeon in each individual case.[2] In general, it may be advised, (1) when injuries necessitate immediate amputations, but the operation should be performed during the period of reaction from shock, or between the sixth and twenty-fourth hour after the accident; (2) If the disease is acute, avoid the period of active inflammation, rapidly-spreading gangrene, and acute pyæmia; (3) In chronic affections the surgeon should regulate the time of operation according to the principles detailed.

[1] F. C. Skey. [2] S. D. Gross. [3] Elwell.

2. **The place of amputation** must be determined with regard (1) to the safety of the patient, and (2) to the serviceableness of the resulting limb; the former must be settled in accordance with the teachings of operative, the latter of mechanical surgery. Fortunately, experience in both branches of surgical art is now in harmony in the selection of the place in most instances. Two principal divisions of amputations have been recognized, based on the place of operation, namely, (1) in the continuity of shaft, (2) in the contiguity or articulation of bones.

These divisions are now comparatively unimportant, as experience proves that, both for safety to the patient [1] and serviceableness of stump, no distinction should be made between amputation in the continuity and contiguity, with the exception of the ankle.[2] In the upper extremity, all the conditions unite in favor of the least possible sacrifice of parts,[3] for the safety of the patient is in proportion to the distance of the wound from the body; and the value of the stump, in prehension, depends upon the number of articulations preserved. In the lower extremity, the same rule applies to the wound, but as the stump is to be used in locomotion, it requires breadth and firmness to sustain contact with the artificial appliances used in progression, and hence a place of amputation must be selected which will secure these conditions. This place is not always the farthest point from the trunk at which an amputation could be performed in a given case, *e. g.*, a medio-tarsal amputation and stump might be possible, but the stump of an ankle-joint amputation would be much more serviceable. But in practice it is not difficult to harmonize the two indications; when the amputation nearer the trunk would give the better stump, the danger of the wound is not so much greater, generally, as to forbid accepting the slightly increased risk for the life-long advantage gained.

3. **The preparations**, to the minutest detail, should be supervised by the operator. Select a firm table, about three feet in height, and cover with two or three folds of blanket; place it so as to have a good light on the stump; provide clean, well-disinfected sponges, towels, slop-basins, a supply of cold water, solution of carbolic acid, 1 to 20; select qualified assistants, namely, one to give the anæsthetic, one to first hold the limb and then apply ligatures; one to use sponges, one to attend upon the instruments; place the patient upon the table and administer the anæsthetic; apply the elastic bandage (Fig. 1), or the tourniquet (Fig. 608); put on whatever robe, gown, or coat is deemed necessary for protection; take a position upon the right side of the limb, grasping it with the left hand, above the point fixed for the operation, and with the right hand take the knife selected,

FIG. 608.

[1] Legouest. [2] E. D. Hudson. [3] T. Bryant.

and hold it in the position adapted to give the freest play of the blade in executing the particular method decided upon.

In the application of the tourniquet to the thigh, first place the cylinder of the roller under the strap (Fig. 608), so that it will be firmly maintained, and then place the cylinder over the artery (Fig. 609), fasten the strap, and turn the screw.

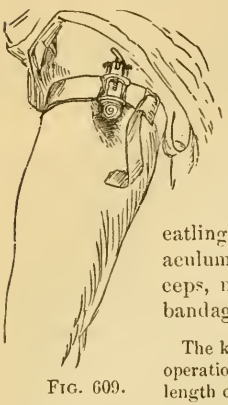
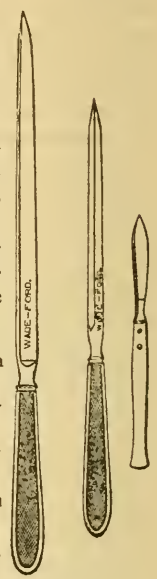


Fig. 609.

4. **The instruments** which are specially required to form a complete amputating case, are a long and short knife, catling, metacarpal saw, scalpel, tenaculum, saw, bone forceps, artery forceps, needles, tourniquet, and elastic bandage.[1]

The knife, *a* (Fig. 610), selected for each operation, should be of about twice the length of the diameter of the limb; the catling, *b*, is a double-edged knife, the two edges being parallel until they converge to form the point; the scalpel, *c*, is large and strong, having a firm handle.



a *b* *c*

Fig. 610.

The remaining instruments are those in common use.

The best atomizer (Fig. 611) gives a large volume of fine spray which becomes a light fog around the operator and his assistants.[2] The coarse spray which atomizers generally deliver is not only very inconvenient to the operator by drenching and benumbing his hands, but it is far less effective as a disinfectant. The antiseptic gauze should be used, if obtainable.

An apparatus which effectually meets the indications of giving a spray as fine as the lightest fog, and continuing for a sufficiently long period without interruption or accident, is the following.[2] It consists (Fig. 611) of a copper tubular boiler, firmly attached to the frame of a spirit lamp, and is provided with delicately constructed tubes for the atomization, by high steam pressure, of the antiseptic solution. The lamp is balanced on a long central pivot, which is firmly connected with a transverse bar. By this arrangement the lamp accommodates itself to all motions and preserves the same level, thereby preventing spilling of alcohol. The whole instrument, when connected, measures eleven inches in height, and seven inches in diameter. The several parts are as follows: — *A*, the tubular boiler which is filled with water and where steam is generated; the openings of tubes or flues are displayed on the upper surface; these tubes, four in number, increase the heating surface of the boiler and carry off the sur-

[1] F. Esmarch. [2] L. A. Sass.

plus heat which would be reflected on the alcohol lamp beneath; *B*, is a safety valve and lid for relief of boiler; *C*, an ivory button for raising the boiler from the frame of the spirit lamp; *D*, ivory handle for rotating the lid and safety valve to permit the filling of the boiler; *E*, ivory screw for securely fixing the lid; *F* is a steam tube and coupling, made of brass; *G*, spray tubes made of silver, with a lining of platina, so that other than carbolized solutions can be used without chemical decomposition; *H*, ivory handle for rotating spray tubes upward or downward as far as required; *I*, ivory screw for fixing spray tubes and regulating the volume and force of the spray; *J*, rubber tubes connected with spray tubes and dipping into medicated fluid; *K*, glass water gauge (with protecting bars) for showing height of water in boiler; *L*, metal band firmly attached to frame of spirit lamp by four perpendicular bars, serves as a flame protector and securely holds the boiler in position; *M*, perpendicular bars connecting base and metal band; *N*, base of the frame of the spirit lamp; *O* is the alcohol lamp; *P*, metal funnel for filling lamp; *Q*, fenestra, showing height of alcohol in lamp; *R*, rachet screw for regulating wick and flame;

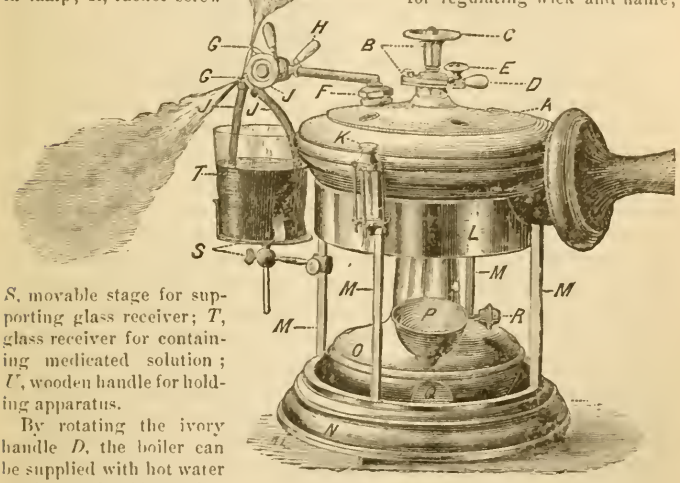


Fig. 611.

S, movable stage for supporting glass receiver; *T*, glass receiver for containing medicated solution; *U*, wooden handle for holding apparatus.

By rotating the ivory handle *D*, the boiler can be supplied with hot water until the liquid reaches the top of the glass gauge *K*; the lamp, *O*, is now lighted and in a few minutes sufficient steam is generated for the development of the spray. A steady uniform and continuous spray issues from each spray tube *G*, *G*, its force and volume being regulated by the ivory screw *I*, and the direction fixed by the ivory handles *H*, *H*. The instrument, now in full operation, and mounted on an adjustable stand, requires no further attention, except, in protracted operations, to replenish the spirit lamp and glass receiver holding the solution, a matter easily accomplished and causing no interruption. The spray thus produced can be thrown a distance of five or six feet, and can be

kept in continuous action for nearly four hours without replenishing boiler or lamp.

If the steam atomizer is not at hand, use the hand atomizer, and if this is not convenient, thoroughly disinfect every part of the wound with a solution 1 to 20. The spray is by no means necessary for the thorough disinfection of fresh wounds, and the good results may be obtained by applying the antiseptic to every part of the open wound, and follow it with carbolized dressings.

5. **The method of operation** should aim to secure a well-nourished covering of the stump, neither scanty nor redundant, and freely movable cicatricial tissue. To obtain such results, (1) the soft parts must be very nicely adapted to the surface to be covered, and well-supplied with blood-vessels; (2) the cut surface of bone must be immediately covered by the periosteum,[1] or the deep fascia of the part, in order to prevent the superficial fascia and integument from becoming too firmly attached to the cicatricial tissue of the end of the bone. These results are secured by raising the periosteum with the soft tissues and applying it to the cut end of the bone.

The objection to the periosteal covering of the bone that osteophytes are liable to form on the extremity,[2] and render the stump tender, are trivial when compared with the advantages which follow the protection which it affords from necrosis and osteo-myelitis, and the basis which it forms for a movable covering. If osteophytes become troublesome, they may readily be removed by a slight operation.

No one method can be adapted to every part and all the conditions under which amputations are performed, and hence great discretion is always required in selecting that method in any given case which will fully meet all indications. It also frequently happens that the mutilation of parts is so great that the surgeon can form the coverings of the stump by no fixed rules, but must exercise his ingenuity in patch-work. But if the conditions essential to a sound and useful stump are constantly kept in view, any of the stereotyped or extemporized methods may be made, with patience and dexterity, to yield the most gratifying results. The recognized methods of amputation are (1) the circular; (2) the single flap; (3) the double flap; (4) the rectangular; (5) the bilateral flap; (6) the periosteal flap.

(1.) **The circular** operation can be executed more quickly by the following than by the ordinary method (Fig. 617): Stand upon the right side of the limb, the left foot thrown forward and placed firmly upon the floor, the right knee bending sufficiently to give freedom of motion to the body; grasp the limb above the point of operation with the left hand, and take the handle of the knife between the thumb and fore and second fingers of the right hand, lightly supported by the other fingers; stooping sufficiently to allow the right arm to encircle the limb readily, carry the knife around until the blade is nearly perpendicular to the long axis of the limb on the side next to you with the point downwards, and the hand above the limb, 1 (Fig. 612).[1] Commence the cut

[1] McGill. [2] L. Ollier.

with the heel of the knife, giving slightly sawing motions, and bring the hand under the limb, 2, and then directly upwards upon the side next to you, 3, until the heel touches the point of commencement, 4; the handle of the knife held thus delicately will change its relative positions as it passes around the limb without the slightest embarrassment to the operator; if the handle is firmly grasped (Fig. 617) in the hand, the incision cannot be completed without the aid of the other hand, or an awkward movement of the hand holding the knife; the ease with which the incision is completed will depend much upon whether it commences well down upon the side of the limb next to the operator; raise the skin from the first layer of muscles by dissection, and turn it upwards, two or three inches, according to the diameter of the limb, like the cuff of a coat. (2.) Divide the first layer of muscles at the margin of the retracted integument by the circular (Fig. 612) incision, as of the skin; raise this layer with the knife and draw it still further upwards; divide the last layer of muscles down to the bone (Fig. 613) by the same sweep of the knife as before given. (2.) Saw the bone at the apex of the cone.

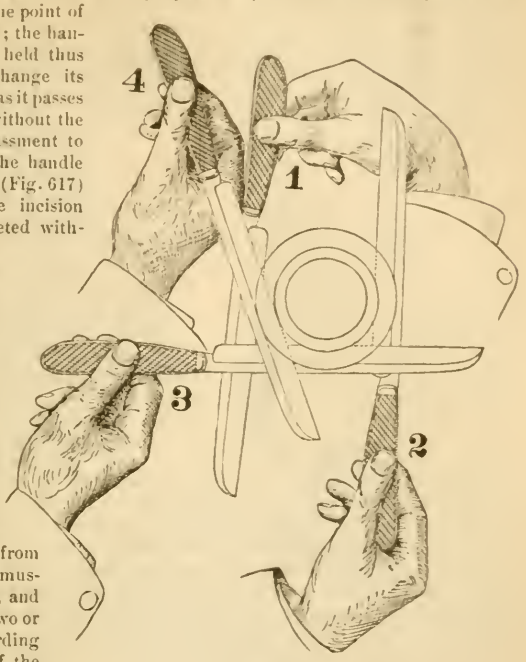


FIG. 612.

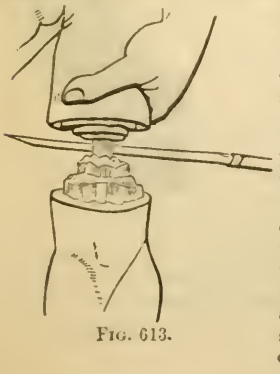


FIG. 613.

(2.) **The single flap**, or a short anterior and long posterior flap, is performed as follows: The patient being placed in the proper position, the operator, standing upon the right side of the limb, grasps the thigh with the left hand, placing the fingers and thumb upon opposite points; he then applies the heel of a long amputating knife on the further side of the limb at the ends of fingers, and drawing it in a semicircular direction over the limb to the end of the thumb, with this single sweep divides

all the soft parts down to the bone; without entirely removing the knife it is withdrawn sufficiently to enter the point at the angle of the wound, and is made to transfix the limb, passing under the bone, and emerging at the angle of the wound on the opposite side; a flap is then cut of the requisite length from the posterior part of the thigh; the flaps are retracted, the knife carried around the bone, and the saw applied at the highest part of the wound.

(3.) **Double flaps** are formed as follows: The patient being properly arranged, the operator, standing upon the side of the limb, grasps the soft parts and brings them forward; he then transfixes the limb, the knife grazing the upper surface of the bone, and makes an anterior flap (Fig. 614); the knife is reintroduced, and passing under the bone a posterior flap is made longer than the anterior (Fig. 614), to compensate for the greater retraction; the operation is completed as in the former method.[1] Flaps may also be made from the sides of the limb; the knife is introduced in the centre of the limb, directly down to the bone, on one side of which it is passed to the opposite side of the limb, and a flap is then formed (Fig. 123); the knife is then introduced and a flap made from the opposite side; the flaps are strongly retracted, and the bone sawed.

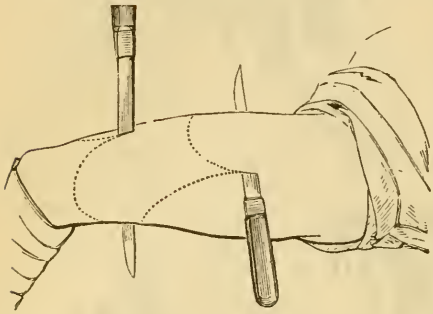


Fig. 614.

(4.) **The rectangular flaps**[2] are made as follows: The operator makes a longitudinal incision on either side of the limb (Fig. 615), in length equal to two thirds of the circumference of the limb at this part; a second incision, extending to the bone, unites the lower extremities of these two incisions; this quadrilateral flap is raised from the bone; a third incision made transversely down to the bone, forms the posterior flap; both flaps are raised and firmly retracted (Fig. 616), the bone sawn at its point in the flaps, and the flaps united.

Fig. 615.

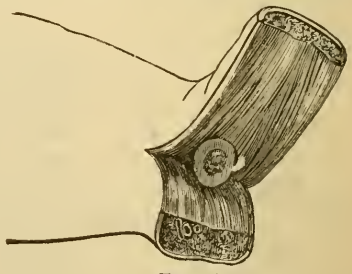


Fig. 616.

(5.) **The bilateral flaps** include only the skin, or may involve all of the soft

[1] Sir W. Fergusson. [2] Teale.

parts down to the bone. The former consists of double flaps of the integuments and circular incision of the muscles;[1] the flaps should be sufficient to meet without effort, should correspond in size, and not be made too arched; in dividing the muscles, the knife, unless the limb be of unusual dimensions, should be carried down to the bone at once, and this can only be done by the application of considerable force, great care being taken that the muscular mass behind the bone be not pushed before the knife, but divided without displacement from its natural relations to the parts around. When the limb is very large, it would be well to divide the superficial muscles first and allow them to retract, before the division of the remainder.

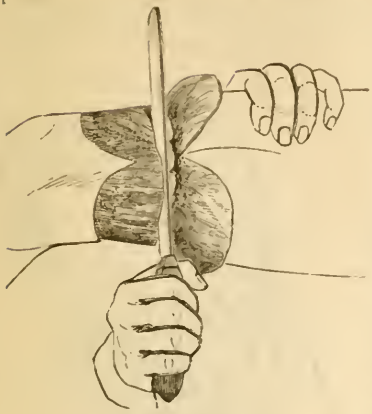


FIG. 617.

(6.) **The periosteal flap** is most perfect when it is raised with the other flap; to effect this readily the incision in any form of operation may be directly down to the bone; if the bone is then divided, an assistant may grasp the extremity with stout forceps while the operator raises the periosteum, beginning at the extremity of the cut bone; the periosteotome may be used, but in general the thumb nails will be found most efficient. The periosteum, thus raised, covers the central part of the flap (Fig. 618), and when the flap is brought over the extremity, the periosteum makes a perfect covering, while the tissues between the skin and periosteum, being uninjured, rapidly unite.

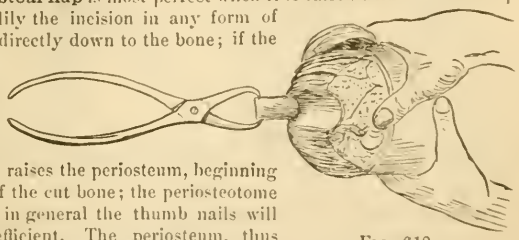


FIG. 618.

6. **The bone** must be carefully divided as follows: The periosteum having been cut completely around the bone, as high up in the flap as possible, employ the saw as does the cabinet-maker, — first apply the heel, and draw the saw slowly but firmly across the bone to make a groove, and then move it with as much rapidity as the operator may choose, until the bone is nearly divided, when it is to be moved more slowly to avoid splintering the last connections; with the bone forceps clip off any sharp or projecting edges, and bevel the end of the bone smoothly. Where there is a single bone it will be found easier to apply the saw nearly perpendicularly on the side opposite to the operator; where there are two bones the saw should be first and last applied to the larger and firmer bone, the smaller bone being completely divided while the saw is engaged in the larger bone.

[1] F. C. Skey.

7. **The wound** must first be protected from hæmorrhage by ligation and torsion of vessels; much valuable time is saved by seizing all the bleeding vessels at once with suitable forceps (Fig. 619), and ligating each one in turn; every point where there is any evidence of hæmorrhage must be examined, and the vessel twisted or tied. The wound must be closed, dressed, and treated according to the principles already given. This object may be accomplished (1) by closing the wound with so large a number of wire sutures that supporting adhesive strips will not be required; by inserting a proper drainage tube so as to relieve the wound of all accumulating fluids; (3) by supporting the parts in such manner by splints, or slings, or pads, that it need not be moved in dressing; (4) the application of such dressings as support and protect the wound, but admit of easy change.

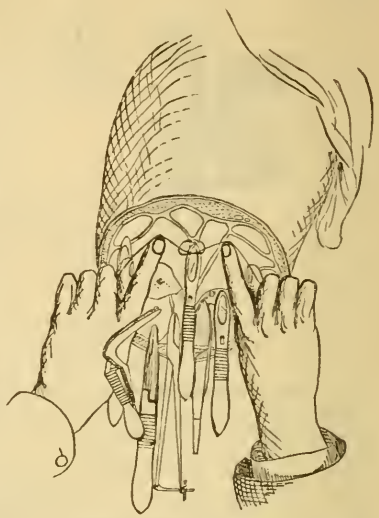


FIG. 619.

The most important features in all methods now recognized are perfect cleanliness, and absolute rest, or freedom from all sources of irritation and excitement. Valuable as is the antiseptic method, carried out in all its details, most excellent results may be obtained in treating wounds by first cleansing the surface with carbolic acid solution, and then supporting the part so that the dressings may be changed without disturbing the wound;[1] or, by leaving the wound open and applying bals. Peru freely while the drainage is free.[2] Or, the wound may be kept entirely dry except the natural drainage, by the dressings; after the application of wire sutures, apply oakum, or cotton wool,[3] with splints. The re-dressing of these wounds is avoided as long as possible, the pulse and temperature being the guide as to the existence of septic matter.[4]

AMPUTATIONS IN THE UPPER EXTREMITY.

Operative and mechanical surgery unite in enforcing the rule that in the hand — and the same is true of the whole upper extremity — no part should be removed that can be saved;[5] no instrument-maker can contrive anything half so good as even one finger.[6]

[1] G. W. Callender. [2] J. R. Wood. [3] A. Guérin. [4] S. Gamgee.
[5] C. J. Guthrie. [6] R. Liston.

1. **The phalanges** are often injured in such a manner as to compel the surgeon to perform a circular flap, or some modified operation to secure the requisite covering. But when the parts will admit, the single palmar flap is preferable in all amputations of the fingers, as the cicatrix is by this method removed to the dorsal surface, the stump is firm and well adapted for use, and the tactile sensation is less impaired.

The first phalanx, *b* (Fig. 620), articulates with the metacarpal bone, *a*, above, and with the second phalanx below; the second phalanx, *d* (Fig. 620), articulates with the first and third phalanges; the third phalanx articulates above with the second, and below presents the free extremity of the finger. The anatomical guides to the articulations are the osseous prominences, *c* (Fig. 620), and the transverse depressions, *c* (Fig 621), in the skin on the palmar surface. Between the bony projections at the side of the finger, at the articulation of the second and third phalanges, a depression marks the position of the articulation; a prominence is readily detected on the dorsum of the second phalanx just in front of its articulation with the distal extremity of the first phalanx; the articulation of the first phalanx with the metacarpal bone, is immediately behind the bony prominences of the proximal extremity of the first phalanx. The transverse depressions in the skin, on the palmar surface of each finger, are three in number, and have the following relation to the corresponding articulations, commencing with the extremities of the fingers, held in an extended position: The first depression is situated about a line and a half above the articulation, *f* (Fig. 621), between the third and second phalanges; the second depression is situated exactly over the articulation, *d* (Fig. 621), between the second and first phalanges; the third depression, *e* (Fig. 621), situated at the commissure of the fingers, is about an inch below the articulation, *b* (Fig. 621), of the first phalanx with the metacarpal bone. When the finger is placed in a state of extreme flexion, it will be seen (Fig. 622), that the relations of the articulation change, and hence the point at which the articulation is to be sought will depend on the position of the finger. The articulations of the phalanges with each other are all ginglymoid; the distal extremities of the first and second phalanges, *a a* (Fig. 623), are smaller than the proximal, *b b* (Fig. 623), and terminate on each side in two lateral condyles, having a slight concave ar-

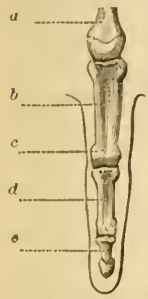


FIG. 620.

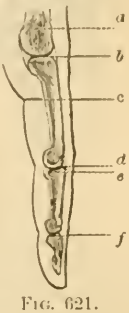


FIG. 621.

FIG. 622.

FIG. 623.

ticular surface between them, which is prolonged on the palmar surface; the proximal extremities of the second and third phalanges present a corresponding prominence in the centre of their articulating surface, dividing it into two concave surfaces, and thus making a ginglymoid joint. They have strong lateral ligaments and are in relation, on their palmar aspect, with the tendons of the flexor muscles. The articulations of the first phalanges, *b b* (Fig. 624), with the metacarpal bones, *a a* (Fig. 624), are enarthrodial; the phalanx alone is movable, and when flexed

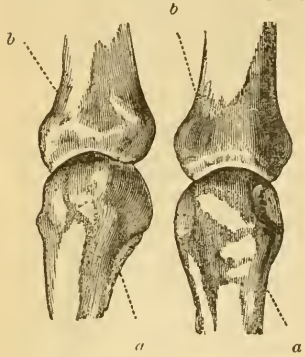


Fig. 624.

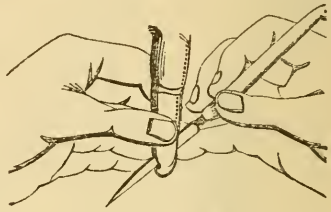


Fig. 625.

at a right angle is carried below the extremity of the metacarpal bone, the articular surface of the latter alone presenting.

In amputation through the shaft, hold the condemned finger between the thumb and index finger of the left hand (Fig. 625), flex the hand upon the forearm to place the other fingers so far posterior as not to be touched by the bistoury; if the flap will not be sufficiently rounded, bring forward the heel of the knife, and cut the flap rounded on the side of the finger nearest the right hand;[1] make a second incision on the dorsum uniting the base of the palmar flap, and divide the bone with a fine saw or cutting forceps.

In disarticulation of the last phalanx, pronate the hand, and require an assistant to hold apart the sound fingers; seize the phalanx with the thumb and index finger, and bend it to an angle of forty-five degrees; recognize the line of the joint as follows: on the dorsal surface there is a well-marked fold in the skin, and the joint is half a line below it; or, if this is not found, recognize the dorsal projection formed by flexion, and cut half a line beyond it; or, seek the termination of the palmar fold, and find the joint half a line below it; take a straight bistoury, and applying its heel perpendicularly on the recognized extremity of the interarticular line, cut from left to right a very small semi-circular dorsal flap, and terminate it at its other extremity, dividing the capsular ligament; without entering the joint, cut the lateral ligaments thus: for the one situated to the left, carry the bistoury on the side perpendicularly to the axis

[1] A. Guérin.

of the last phalanx, the handle nearer the operator than the point, and the edge also slightly turned toward the operator: this incision is perfectly suited to the articular surfaces, and the ligament is divided at the first cut; cut the second lateral ligament in the same manner, the handle of the bistoury being turned downwards, and away from the operator.

These three steps may be comprised in one, and the skin, the dorsal and lateral ligaments divided at once. When the distal phalanx alone is involved, as in caries or necrosis, the nail and soft parts should, if possible, be preserved; it is nearly always feasible, and, if the periosteum has not been destroyed, it is not unfrequently followed by reproduction of the phalanx, though rarely in a perfect manner.[1] Bring the palmar flap into position, secure it by a narrow bandage laid over the stump in the direction of the long axis of the finger, then make fast by a few turns of the roller.[2] To disarticulate the second phalanx the proceeding is the same, only the dorsal incision should start on each side on a level with the palmar fold in the skin.[3]

2. **The entire finger** may be removed at the metacarpo-phalangeal articulation.

The joint is located an inch above the commissure, or it may be recognized by making strong traction on the finger and thus separating the joint.

Grasp the finger in a prone position on its palmar and dorsal surfaces by the fingers and thumb of the left hand, and flex to an angle of forty-five degrees; commence an incision on the dorsal aspect of the joint a quarter of an inch above at *a* (Fig. 626), and carry it down to the commissure, *c*, then across the palmar surface to the opposite side, *b*, in the fold of the skin, the finger being forcibly extended; thence, the finger being again flexed, the incision is continued upwards to *a*; dissect the borders of the wound from the head of the phalanx, enter the joint on its dorsal aspect, divide the extensor tendons and lateral ligaments, increase the flexion with an effort to luxate the joint which renders the flexor tendons easy of division. To give greater symmetry to the hand, the head of the metacarpal bone may also be removed. Or, double flaps may be made, *a*, *b*, *c* (Fig. 626).

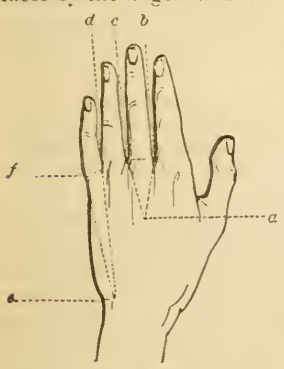


Fig. 626.

3. **The four fingers** may be removed at a single operation.

The distal extremities of the metacarpal bones are not all on the same line; those of the index and ring are nearly on a level, while that of the middle finger is about half a line lower, and that of the little finger is a half a line higher.

[1] S. D. Gross. [2] F. H. Hamilton. [3] Lisfranc.

The hand being well pronated, grasp the four fingers with the left hand and flex them moderately while an assistant supports the hand and retracts the skin as much as possible; with a straight, narrow knife, make a curved dorsal incision, *a*, *b*, *c* (Fig. 627) with its convexity looking downwards, from six to eight lines below the heads of the metacarpal bones, from the index towards the little finger, if the left hand, and in the opposite direction, if the right; the extensor tendons being exposed by the retraction of the integuments, which is assisted by a few strokes of the knife, open each of the metacarpo-phalangeal articulations; divide the extensor tendon first, then the lateral, and finally the palmar ligamentous attachments; carry the knife through the articulations to the palmar aspect of the phalanges, and cut out a flap, which is limited anteriorly by the folds in the skin at the base of the fingers on their palmar surfaces.

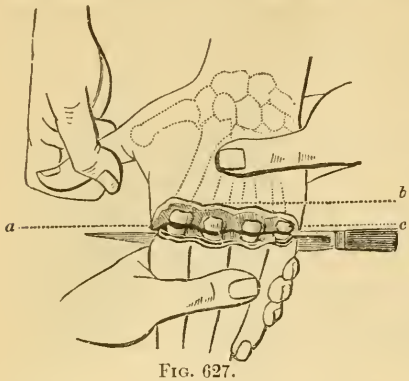


FIG. 627.

By the same method, two or three fingers may be amputated, the sound fingers being held aside; the dorsal flap is then formed by the point of the knife; or the hand may be held in the supine position and the flap made first from the palmar surface.[1] The appearance of the stump is improved by sloping the projecting portion of each knuckle with cutting pliers.[2]

4. **The thumb** may be amputated at its phalangeal or metacarpal articulation. The first is performed in the same manner as that of the fingers, but the removal at the metacarpo-phalangeal articulation requires large flaps, owing to the great size of the head of the metacarpal bone. Make an incision on the dorsal aspect, convex upwards, the centre being a little above the joint, and the extremities terminating on each side at the end of the palmar transverse fold, extend the thumb and make a palmar convex incision, uniting the extremities of the first, the centre extending midway between the transverse cutaneous fold alluded to and that marking the articulation of the first and second phalanges; open the joint and complete the disarticulation, removing the sesamoid bones. The palmar flap, applied to the end of the bone, should accurately fit the curved incision above.

[1] Lisfranc. [2] S. D. Gross.

5. **A single metacarpal bone** is removed by an incision on the dorsal aspect, corresponding in length with the portion of the bone to be removed. Separate the soft parts cautiously from the bone, the knife being carried parallel with its long axis to avoid wounding the palmar arch; having made the incisions on both sides, pass the point of the knife under the bone, so as to appear at the opposite side, and then, by carrying it forwards in contact with the under surface of the bone, divide the soft parts at one section; if the operation is of either the third or fourth metacarpal bone, the section should be made with the bone forceps; if of the metacarpal bone of the thumb, saw it perpendicularly to its axis; if of the index finger, make a section obliquely from without inwards, the hand being supine; if of the little finger, from within outwards (Fig. 628) *a*, the soft parts being withdrawn by the retractor, *b*.

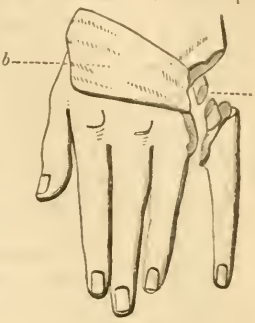


FIG. 628.

6. **Amputation of the four metacarpal bones** (Fig. 629) is made as follows: Make a palmar flap as in disarticulation of all the fingers and a similar incision on the dorsum; pass the knife into the interosseous spaces, separate the muscular attachments and divide the periosteum, apply a five-tailed retractor *a* (Fig. 629), and saw the bone with a metacarpal saw.

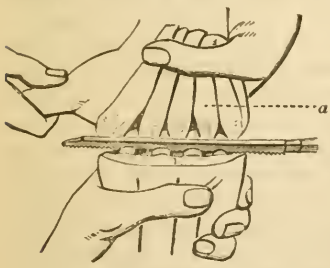


FIG. 629.

7. **Disarticulation of the first metacarpal bone** is performed as follows:—

The joint is of a mixed character, between arthrodial and ginglymoid: on its dorsal surface it is almost subcutaneous, but covered with thick muscle on its palmar aspect; the radial artery passes around its ulnar side; it has a loose capsule; the joint runs in an oblique direction, in a line drawn from its external side to the root of the little finger; it is easily determined by the projection of the enlargement of the head of the bone, on pressing the thumb into the palm; or, it lies an inch and a quarter below the styloid process of the radius.

Hold the hand in a position between supination and pronation; make an incision along the dorsal surface of the metacarpal bone of the thumb, commencing six lines above its articulation, *a* (Fig. 630), with the trapezium, and extending through all the tissues

down to the bone, to the inner side of the head of the first phalanx of the thumb, on a level with the commissure, *b*, between the thumb and index finger; carrying the hand to pronation, continue the incision around the palmar surface of the phalanx to its outside, *c*, and thence to the dorsum of the metacarpal bone to join the first incision about its middle; detach the muscles and integuments from either side of the bone, and open the articulation from its dorsal aspect, *a* (Fig. 630); then endeavoring to dislocate the bone outwards, complete the division of its remaining attachments.

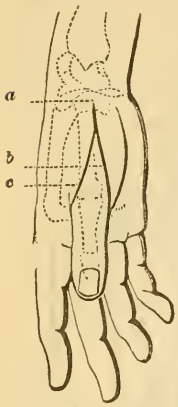


Fig. 630.

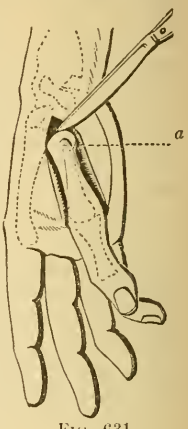


Fig. 631.

8. **Disarticulation of the second metacarpal bone** is rendered especially difficult on account of the prolongation of that part of its head that is in relation with the trapezoid, os magnum, and third metacarpal. The hand held in pronation, the thumb and fingers separated, make an incision, commencing about half an inch in front of the styloid process of the radius, but on a line with the second metacarpal bone, *d* (Fig. 632), and continue to the internal side of the base of the first phalanx, *a;* now carry it around the palmar surface in the cutaneous fold — represented on the dorsum by the line *b*, *c* — to the point *c*, and thence to point of commencement, *d;* dissect the soft parts by keeping the knife close to the bone, the wound being held apart; carry the knife up along the internal side of the bone to the union of the two metacarpal bones, and, turning its edge inwards, divide the interosseous ligament, and, in the same manner, enter the knife into the articulation of the metacarpal bone with the trapezius; the anterior and posterior ligaments are next divided, the bone dislocated, and the knife entered flatwise and horizontally under the upper part of the bone *a* and *b* (Fig. 633), is carried downwards, completing the operation; care should be taken in dividing the ligaments not to penetrate any adjoining articular cavity.

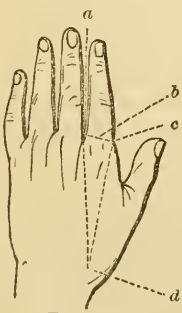


Fig. 632.

9. **Disarticulation of the fifth metacarpal bone** may be performed by two methods: —

The unciform receives the fifth metacarpal bone, upon a surface concave from behind forwards; the line of articulation, if prolonged, would fall upon the middle of the second metacarpal bone.

(1.) Pronate the hand and commence an incision one line above the articulation *a* (Fig. 634), and carry it along the dorsum to the commissure, *b*, then under the finger, along the fold of the integument

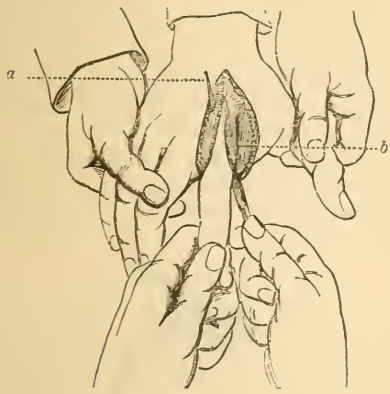


Fig. 633.

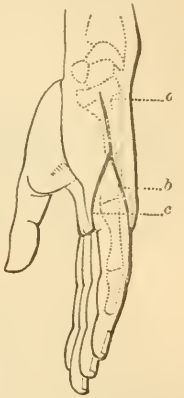


Fig. 634.

to the opposite side, and from thence back to the point of departure, *a;* dissect the soft parts from the bone and disarticulate. (2.) (Fig. 634.) The hand being held in a state of forced pronation, commence an incision six lines above the carpo-metacarpal joint, *a*, and carry it down in a straight line to the inner border of the first phalanx of the little finger, until it meets the depression at the base of the little finger, on its palmar surface, *b;* then continue it around the base of the finger following this depression exactly; and, lifting the little finger, continue the incision around to its inside, *c* (Fig. 634), and upwards to join the first portion about opposite to the centre of the metacarpal bone; detach the integuments and muscles from the bone, and divide its articular connection with the point of the bistoury in the manner already described. The wound after the operation is seen in Fig. 635.

Fig. 635.

10. **Disarticulation of fourth and fifth metacarpal bones** is as follows: Make a transverse incision a little in front of the articulations, another parallel to the axis of the metacarpal bones, upon the dorsum of the fifth, in order to cut upon that part a dorsal flap which is to cover

the whole ulnar side of the wound after the operation; the disarticulation is thus effected, and a small flap formed, which must be separated down to its base in the palm of the hand, in order to be able to raise it upon the transverse branch of the wound.[1] The same process is adapted to any other two metacarpal bones.

11. **Disarticulation of the metacarpal bones of the four fingers** is performed thus: Hold the hand in the position of forced supination and introduce, opposite the articulation of the fifth metacarpal with the unciform bone, a small, straight knife between the bones and the soft parts, carrying it a little below the projections formed by the unciform and the trapezium, so as to bring out its point below the thumb; carry the blade of the knife along the palmar surfaces of the metacarpal bones, and cut out a large flap of an elliptical outline, *a*, *b*, *c* (Fig. 636), turn the hand in a prone position, and make a semicircular incision across its back, two thirds of an inch below

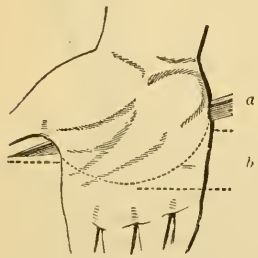


Fig. 636.

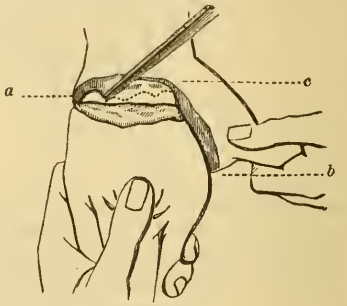


Fig. 637.

the line of the articulations, and carrying the knife through the tissues connecting the thumb with the index finger, *a*, *b*, *c* (Fig. 636), join the first incision; while an assistant is drawing the integuments upwards, hold the metacarpus in the left hand, disarticulate from the front, commencing with the metacarpal bone of the index or little finger, according as the operation is upon the right or left hand.[2]

12. **Radio-carpal disarticulation** gives the best results when a flap is taken from the palmar surface of the hand.

To determine the articulation: (1.) Strongly bend the hand backwards; the summit of the angle formed by it with the forearm indicates the radio-carpal articulation. (2.) Feel in front the transverse process of the radius; the joint is one line below it, and about half an inch above the crease in the skin that separates the palm of the hand from the forearm. (3.) Determine the summit of the styloid processes, and draw a transverse line between them; this line will be two lines and a half below the joint.[3]

[1] Velpeau. [2] Maingault. [3] Malgaigne.

A single palmar flap is made as follows: An assistant holds the hand in a supine position: grasp the extremity in the palm of the left hand, placing the thumb and forefinger on the extremities of the styloid processes; make a semicircular incision on the palm (Fig. 638) from just below the processes, having its concavity upwards; dissect the flap and turn it back, and divide the tendons, the radiocarpal and lateral ligaments. Or, make the first incision on the dorsum, open the articulation and pass the knife through (Fig. 639), forming a palmar flap three inches in length.

Fig. 638.

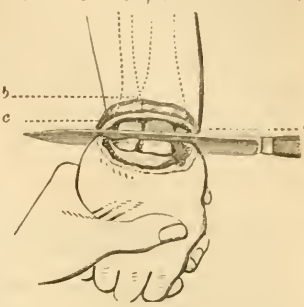


Fig. 639.

13. **Amputation of the forearm** is best performed in the lower part by the circular, and in the upper part by the flap method, for in the lower portion the soft tissues are mostly tendinous, and in the upper, muscular; its arteries are the radial, ulnar, and anterior and posterior interosseous; two bones are to be divided, of different diameters, at different parts of the limb.

(1.) **The circular** operation is as follows: The forearm being held in a position between pronation and supination, make a circular incision through the skin and subcutaneous cellular tissue; turn up the skin like the cuff of a coat, and if it should not retract easily, owing to the conical shape of the limb, make a lateral incision; now divide circularly the muscles at the border of the flap of skin, and turn it over still further; then raise an inch or more of periosteum from each bone, incising it first along its attachments on the inner borders of the bone; at the highest point where the bones are denuded, draw the saw, slowly at first, across the radius and ulna, taking care to saw through the radius first (Fig. 641), as the ulna, being more closely attached to the humerus, serves as a support for the limb; tie the radial, ulnar, the anterior and posterior interosseous arteries; cleanse the wound with carbolic solution.

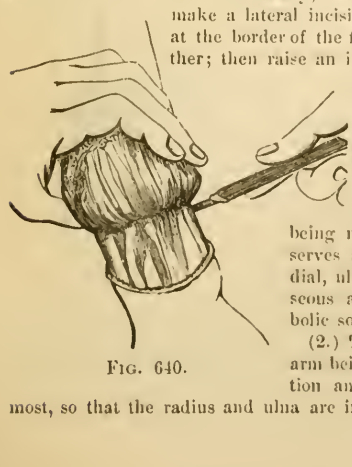


Fig. 640.

(2.) **The flap** may be single or double. The arm being held in the position between pronation and supination, with the thumb uppermost, so that the radius and ulna are in one line, enter a sharp-pointed knife

close to the inner edge of the radius and bring it out opposite at the edge of the ulna: if a single flap is to be made, it must be taken from the anterior face, and be long enough to completely cover the stump; if a double flap is preferred, make an anterior flap the length of half the diameter of the arm, and a posterior flap of equal length; turn back the flaps, divide the tendinous muscular or interosseous fibres not cut through, and divide the bones as in the circular operation. Bilateral flaps of the integuments and circular incision of the muscles is often preferred, to avoid projection of the ulna.[1] The rectangular flap[2] method is also adapted to the lower part of the forearm.

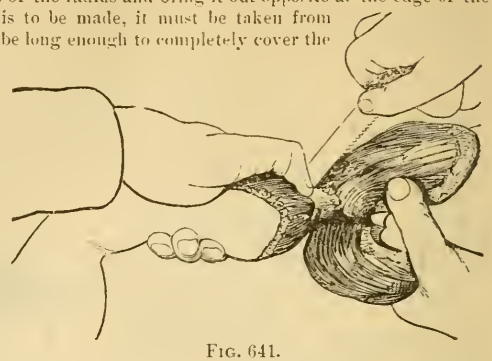


Fig. 641.

14. **Amputation of the elbow-joint** is to be preferred to amputation through the arm, if no artificial arm is to be applied, as the stump is broad and firm, and can be made more useful. The circular and single anterior flap methods are adapted to this articulation.

The exact position of the joint is determined by careful attention to the anatomical relations of the following osseous prominences about the joint: the epicondyles, or the most prominent points on the condyles of the os brachii, *b*, *f*. *c* (Fig. 643), are recognized, the internal more readily than the external; also the olecranon, *c* (Fig. 643), a line drawn through the lower points is, on the outside, a quarter of an inch above the interarticular line, *b*, *f*, *c* (Fig. 642), and on the inside three-quarters of an inch; the articulation of the radius and humerus is transverse, that of the ulna irregular, and owing to its projections, must be entered externally. Two facts result: first, that the articular interline is very oblique from without inwards and from above downwards; second, that it is very much below the tuberosities of the humerus. If then, in cutting the anterior flap, its base is extended up to the level of these tuberosities, it will almost always be too short to cover the bone,

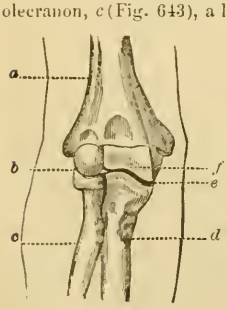


Fig. 642.

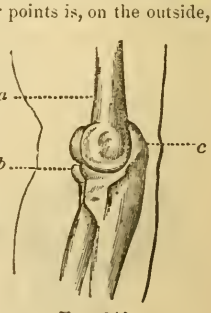


Fig. 643.

[1] F. C. Skey. [2] Teale.

which will project, especially on the inside and downwards; therefore, enter the knife one inch below the middle projection of the epitrochlea, to bring it out half an inch below the projection of the epicondyle.[1]

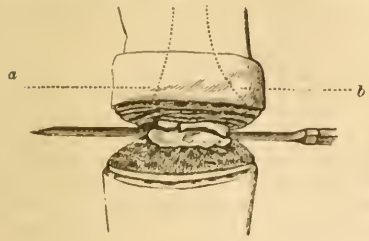


Fig. 644.

(1.) **The circular** method is as follows: The arm being held in a supine position make a circular incision through the skin only, three to four inches below the joint; dissect up the integuments to the joint, and reflect backwards, *a*, *b* (Fig. 644); divide the muscles in front, and the ligaments, enter the joint and complete the disarticulation by dividing the triceps, or sawing off the olecranon; the brachial artery is divided above its bifurcation.

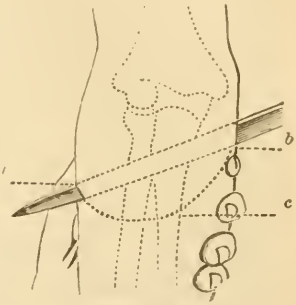


Fig. 645.

(2.) **The single anterior flap** is made thus: Supinate and slightly flex the limb; raise the soft parts from the bone in front of the joint, enter a straight knife an inch below the internal condyle, traverse the limb close to the ulna, until it appears one and three-quarter inches below the external condyle, to allow for retraction of muscles arising from the humerus; cut an anterior flap, *a*, *b*, *c* (Fig. 645), about three inches in length; retract this flap, *a* (Fig. 646), and pass the knife behind the limb, and enter the heel on the outside between the radius and os brachii, *e*, and extend the incision, draw it across the back part of the joint, dividing all the tissues to the internal angle of the wound; divide the anterior ligament, *c*, *d* (Fig. 646), and the lateral ligaments, luxate the bones forwards, cut the triceps and complete the operation.

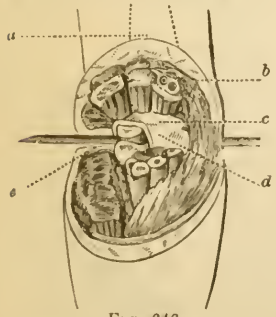


Fig. 646.

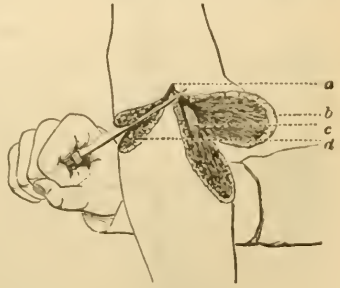


Fig. 647.

[1] J. F. Malgaigne.

(3.) **An external flap** may be preferred in some cases of accident:[1] Make the flap by transfixing the limb upon the outside, entering the point of the knife just within the head of the radius, *a* (Fig. 647), traversing the neck, *c*, and cutting out a larger external flap, *b*; a second flap is made from the inside of the arm, by cutting from without inwards, and from below upwards, *d*; the soft tissues immediately covering the joint are divided, and disarticulation completed; a good covering is thus made for the condyles.

15. **Amputation of the arm** may be performed at any point, but, as a rule, as little should be sacrificed as possible. Owing to its uniform size, and single central bone, any of the different methods may be applied, but the periosteum should always be raised, as a covering to the bone.

The humerus is covered in its lower part by muscles closely attached; in the upper part large muscles are inserted into it, which have their origin from the thorax, shoulder, and back, which, when divided, tend to retract and leave the bone bare; the only artery always requiring the ligature is the brachial.

(1.) **The circular** is as follows: Place the arm at right angles to the body; standing on the right side of the limb, make a circular incision through the integuments; roll the flap one to two inches, according to the size of the limb; make a second incision at the margin of the retracted skin; divide and retract the superficial muscles, and make a third incision down to the bone; raise the periosteum an inch, and saw the bone; secure the brachial artery which lies on the inside, between the biceps and internal portion of the triceps muscles; carbolize the wound, and bring the edges together from before backwards; it may be closed from side to side, or even obliquely.

(2.) **The flap** may be single and may be made at any point presenting on one surface a sufficient amount of tissues; two flaps of equal size are generally anterior and posterior; the arm being carried at a right angle with the body, grasp with the left hand the tissues on the anterior or lateral part of the arm, and passing the knife down to the bone, carry it over to the opposite side, and cut out a flap three-fourths the diameter of the limb in length (Fig. 648), enter the knife close to the bone on the opposite side, and make a similar flap; firmly retract the flaps, divide the tissues covering the bone, and saw the bone in the highest point between the flaps (Fig. 649). If one flap is formed, grasp the tissues on the anterior part of the limb, placing the thumb and index finger at opposite points; with the left hand above the place of operation, fix the heel of the knife at the point of the fingers, on the opposite side of the limb, and with a slight down-

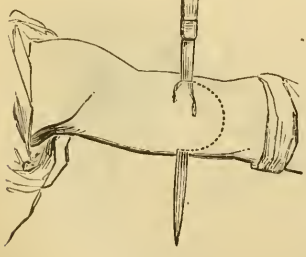


FIG. 648.

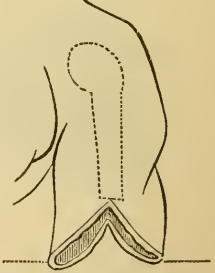


FIG. 649.

[1] A. Guérin.

ward curve bring it over to the point of the thumb, dividing with one stroke the tissues to the bone; withdraw the knife until the point rests in the angle of the wound, then thrust it under and close to the bone, taking care that the point emerges at the angle of the first cut on the opposite side where the incision commenced; make a flap of sufficient length to cover the stump; divide the remaining soft parts with a circular incision, and saw the bone in the line of division.

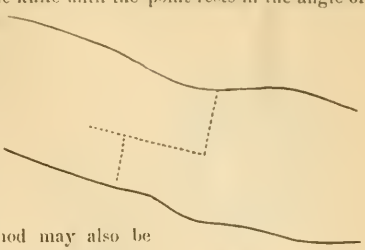


Fig. 650.

(3.) **The rectangular flap** method may also be performed on the lower part of the arm, the line of incision being followed according to the rules specified.

16. **The shoulder joint** may be disarticulated by several methods. This joint is arthrodial; the articular head of the os brachii is very broad, and articulates by scarcely one third with the shallow glenoid cavity of the scapula; it is connected, too, by a loose capsular ligament; the joint is strengthened by the long head of the biceps, and the muscles arising from the scapula and inserted in the vicinity of the joint; the joint is protected above by the extremity of the clavicle, and the acromion process. The artery must be compressed on the first rib with the thumb or a padded key above the clavicle; or the elastic tube may be applied through the axilla and over the shoulder (Fig. 651).

Fig. 651.

The oval method[1] is still most in favor. Make a vertical incision from the edge of the acromion process to a point one inch below the top of the humerus down to the bone (Fig. 652). Make two oblique incisions starting from the middle of the vertical one on the anterior, the other on the posterior aspect of the joint, carrying them through the tissues composing the anterior and posterior walls of the axilla, to the lower border of each, and dividing their attachments to the humerus. Push the edges of the wound on either side to expose the joint, and open it, making traction on the bone to put its ligament on the stretch; luxate the bone, pass the knife behind it (Fig. 653) and finish the operation by cutting directly through the

[1] Larrey.

tissues in the axilla, which intervene between the extremities of the incisions already made, recollecting that they contain the artery, which requires

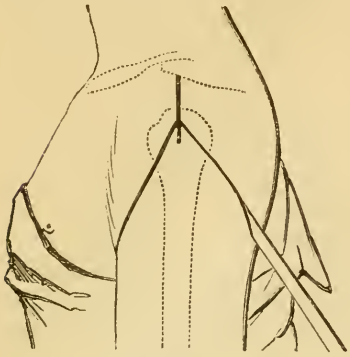


FIG. 652.

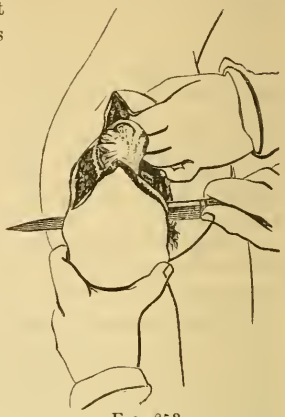


FIG. 653.

to be compressed by an assistant. The wound which results from this operation is almost perfectly oval in shape. Or, the head of the bone may be dissected from its cavity, with the knife held vertically, first upon one side and then upon the other, *a*, *b*, *c* (Fig. 654), and completed by dividing the axillary portion.[1]

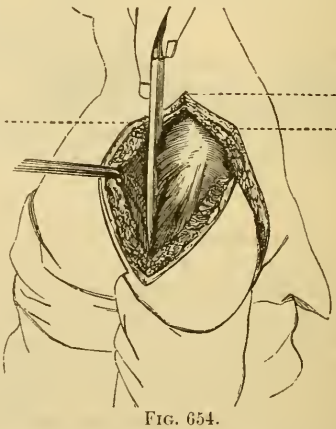


FIG. 654.

1. The single flap method[2] is as follows: The arm being held away from the trunk, grasp the deltoid in its entire length and thickness in the left hand; and with the right pass a double edged knife through its base, under the acromion, and grazing the surface of the humerus, cut an external and superior flap of sufficient extent; an assistant raises it; then, by approaching the arm to the body, expose the tendons of the muscles inserted into the head of the humerus and cut them; grasping the arm with the left hand, dislocate the head of the bone outwards, pass the knife behind it and incise the soft parts, while an assistant seizes the flap in such a manner as to prevent hæmorrhage from the divided axillary artery, and, if the tissues are hardened,

[1] Guérin. [2] Dupuytren.

taking great care not to allow air to enter the veins.[1] The flap might be made by cutting from without inwards, commencing the incision, on the left side, near the anterior border of the deltoid, on a level with the articulation; descend in a curved line to within two thirds of an inch of the insertion of the deltoid, and then ascending on

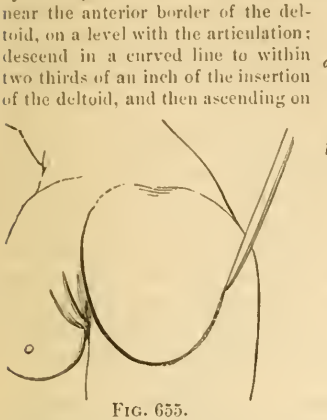


Fig. 655.

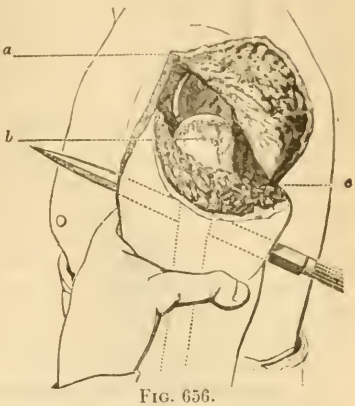


Fig. 656.

the posterior part (Fig. 655) to the same level as it was commenced; dissect up the flap, and disarticulate the limb[2] as before.

2. **The double flap**[3] is as follows: The arm is kept close to the trunk, the head of the humerus being pushed upwards and outwards as much as possible; recognize the exact position of the acromion and coracoid processes; on the left shoulder enter the point of a long knife almost parallel with the humerus at the outer side of the posterior border of the axilla, in front of the tendons of the latissimus dorsi and teres major muscles, c (Fig. 656). As the knife passes in the plane of its blade it should form an angle of thirty-five degrees with the axis of the shoulder, and its point should graze the posterior and external surface of the humerus, until it reaches the under surface of the acromion; at this point, the handle of the knife should be raised, and its point lowered so that it is brought out below and in front of the clavicle, *a*, in the triangular space between the acromion and coracoid processes, which is bounded posteriorly by the clavicle. Make the knife cut its way outwards around the head of the humerus, *b*, and as soon as it becomes disengaged from beneath the acromion process, carry the arm away from the trunk; now grasp the deltoid muscle with the left hand, raising it as much as possible from the bone, and carry the knife directly downwards, grazing the bone, and cut out a semicircular flap about three inches in length. In making this flap the upper part of the capsule of the joint should be divided as well as the tendons of the latissimus dorsi, teres major and minor, and part of the deltoid; raise the head of the humerus from the glenoid cavity, pass the

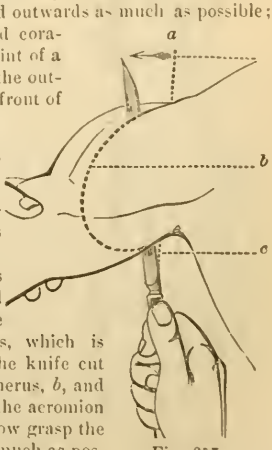


Fig. 657.

[1] S. D. Gross. [2] A. Guérin. [3] Lisfranc.

blade of the knife behind it, and carry it downwards and forwards, grazing the humerus, to cut out the internal flap, and at this moment the axillary artery should be compressed by an assistant. In operating on the right shoulder, the same rules are followed, except that the knife should be entered in the infra-clavicular triangle, *c* (Fig. 657), and brought out at the posterior border of the axilla, *a*, thus reversing the direction of the knife in transfixing the articulation, to cut out the posterior flap.

AMPUTATION OF THE LOWER EXTREMITY.

Under all circumstances, except where poverty and advanced age, and confirmed dissolute habits, so combine in the individual as to render it certain that mechanical appliances would be of little service, give the patient the stump best adapted to the most useful artificial limb. In all amputations of the lower extremity, the surgeon should be governed in the selection of the point of operation and the method to be adopted: (1.) By the mortality of the operation in question; (2.) By the adaptability of the stump to the most serviceable artificial limb for locomotion.[1]

1. **Amputation of the phalanges** in the continuity or contiguity is performed by the same rules as have been given for similar amputations of the fingers; a flap being generally formed from the plantar surface.

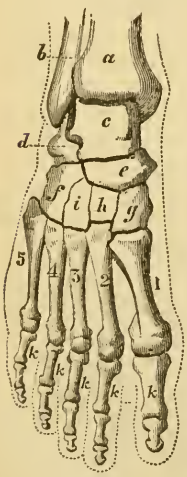


Fig. 658.

2. **Disarticulation of single toes** must be undertaken with due regard to the following facts, viz., the extremity of the first metatarsal bone, 1 (Fig. 658), is large, and requires a very liberal flap to cover it; on the plantar face of the articulation are two or three sesamoid bones; the interarticular line is further from the interdigital fold than in the hand, but the second space is much nearer the joint than the others.

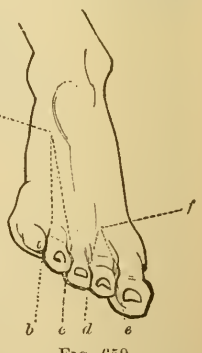


Fig. 659.

(1.) **The oval method** is as follows: Holding the toe with the finger and thumb, commence an incision over the joint, *f* (Fig. 659), and carry it downwards and forwards, along the side of the toe to the commissure of the toes, around, under the toe, along the transverse linear depres-

[1] Report of Drs. Valentine Mott, Gurdon Buck, John Watson, Alfred C. Post, Willard Parker, Ernst Krackowizer, W. H. Van Buren, and Stephen Smith.

sion to the opposite side, and thence up to the point of commencement; divide the extensor tendons and lateral ligaments with the point of the knife, open the joint, and complete the disarticulation by cutting the tissues upon the under part of the joint.

(2.) **The single plantar flap**, for the second, third, and fourth toes, requires a transverse incision over the joint, and lateral incisions to divide its connections; depress the toe, and pass the knife through the joint and along the under surface of the bone until a sufficient flap is formed. The lateral flap for the great and for the little toe is made thus: enter the joint by cutting through the com-

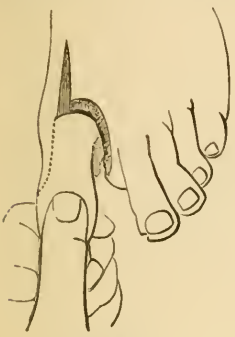


FIG. 660.

FIG. 661.

missure, the knife being held vertically, and complete the operation by carrying the knife through the joint and along the outer or inner side of the bone, forming a flap of the requisite size (Figs. 660, 661).

(3.) **The double flap** is thus made: holding the toe in the left hand, and, recognizing the articulation, transfix the soft parts by passing the knife from the plantar to the dorsal surface on one side, emerging over the middle of the joint, and cutting a flap from the side as far as the edge of the commissure; open the joint on the side, pass the knife through and cut a flap from the opposite side, by passing the knife along the bone; or, the second flap may be cut by transfixing as the first. Or, amputate the toe thus: bend the toe downwards, and make a dorsal flap across the middle of the phalanx, from the integumental fold, between it and the second toe, to the side of the ball of the first toe, and reflect it; a similar line below, uniting the ends of the first flap by a circular sweep of the knife, forms the lower flap; disarticulate the bone, and complete by cutting out the lower flap. Or, make a straight longitudinal incision along the inner side of the toe, commencing about half an inch behind the articulation, and carry it onwards to the middle of the first phalanx.

3. Disarticulation of all of the toes is through the metatarso-phalangeal articulations.

These joints (Fig. 658) represent a curved line with its convexity downwards, due to the difference in the metatarsal bones; the second is a half a line longer than the first, the third is a half a line shorter than the second, the fourth is half a line behind the third, the fifth is still further behind.

The single flap is made in nearly the same manner as in amputation of all the fingers; the incision, *a*, *b*, *c*, in relation to the joints, is seen in Fig. 662. If the operation is on the left foot, grasp the toes with the left hand, the thumb applied to the backs of the toes, and make a semicircular incision in front of the joints, commencing at the internal side of the head of the first metatarsal bone, and ending at the external side of the fifth; dissect up the flap, open the joints, and divide the lateral ligaments with the point of the knife; now pass the knife behind the phalanges and cut a flap from the plantar surface. Or, make the plantar flap by extending an incision along the cutaneous fold at the base of the phalanges and dissecting backwards (Fig. 663).[1]

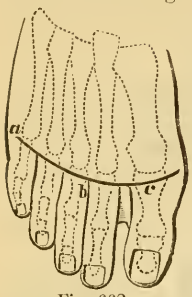


Fig. 662.

4. **Amputation through the metatarsal bones** is performed with plantar and dorsal flaps, as on the metacarpus. Make a curved incision on the dorsum of the foot, convex downwards, dividing the soft parts down to the bone; transfix the plantar surface, grazing the bones, and make a flap reaching to the commissure of the toes; divide the interosseous muscles with the point of the knife, apply a sixtailed retractor, and divide the bones with a fine saw (Fig. 664).

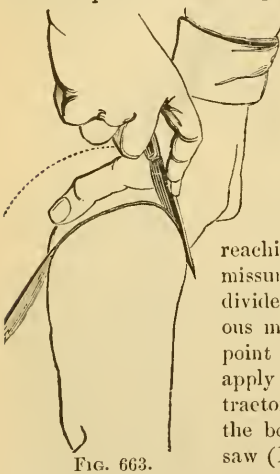


Fig. 663.

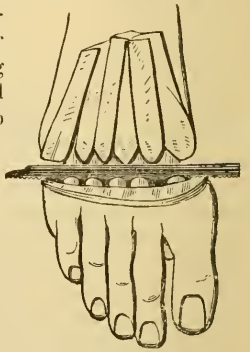


Fig. 664.

5. **Disarticulation of the first metatarsal bone** is best performed by the oval method.

It has four ligaments, an internal, dorsal, plantar, and interosseous; the articulation is one or two lines behind the first projection found on the posterior portion of the metatarsal bone, and an inch anterior to the prominence of the scaphoid, *e* (Fig. 658); the direction of the line of articulation is from within forwards and outwards; the dorsalis pedis artery passes to the sole of the foot on the outer side of the joint.

[1] Guerin.

Commence two lines behind the joint, *a* (Fig. 665), an incision directed obliquely from within outwards, to the commissure of the toes, *c*, and pass around the base of the first phalanx, following the crease on its plantar surface; withdraw the bistoury and replace it on the internal side of the phalanx, *b*, in the inferior angle of the incision, ascend on the internal side of the metatarsal bone and phalanx, and following a line slightly oblique from within outwards, rejoin the point of commencement; the skin being cut, divide successively in the whole extent of the incision the extensor tendons of the toe and fibres of the dorsal interosseous muscle. Dissect out the bone, leaving the sesamoid bones in the phalangeal articulation, divide the internal ligament, holding the point of the instrument perpendicularly and the edge slightly oblique from within outwards and from behind forwards to follow the direction of the joint; next, divide the superior ligament, and direct the bistoury upwards and push its point at an angle of forty-five degrees into the interosseous space, formed by the external surface of the first cuneiform and the extremity of the second metatarsal bone; when the point has penetrated to the plantar layer, raise the blade again to the perpendicular and divide the interosseous ligament.

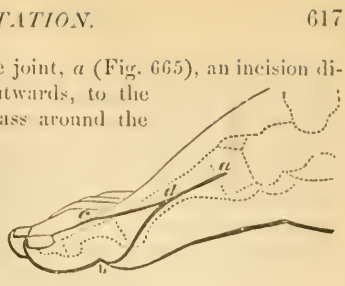


Fig. 665.

6. **Disarticulation of the fifth metatarsal bone** is by the oval method.

This bone articulates with the cuboid, *f* (Fig. 658), by a triangular surface, and with the fourth metacarpal; it has a tubercle on the external part of its base, which is easily felt and into which is inserted the peroneus brevis muscle; the line of the articulation is obliquely forwards and inwards.

Commence an incision just behind the joint, *a* (Fig. 666), carry it forwards towards the commissure, *b*, thence under the toe, along the transverse linear depression to the opposite side, *c*, and then along the external margin to *a*, the point of departure; dissect the soft parts from the bone and enter the joint found just behind the tubercle; from the outside, divide the ligaments which unite it to the fourth metatarsal, and complete the operation by dividing the plantar ligaments.

Fig. 666.

7. **Disarticulation of single metatarsal bones** may be made by

the oval method. Commence an incision just behind the joint, *a* (Fig. 665), carry it forwards towards the commissure, *c*, thence under the toe along the transverse linear depression to the opposite side, *b*, and terminate at *a*, the point of beginning; dissect the soft parts from the bone and cut the ligaments uniting it to the third and fifth metatarsal and cuboid, and complete by dividing the plantar ligaments.

8. **Disarticulation of the two outer metatarsal bones** is made as follows: Commence an incision a finger's breadth behind the joint of the fifth metatarsal bone, in the middle, between the articulation of the two bones; carry it forwards to the commissure, then along the under surface in the transverse line to the outer side of the little toe, and thence back to the beginning; dissect the soft parts from the bones, divide the lateral ligament, and disarticulate the joints by entering them from the outside, and following the line above given (Fig. 667).

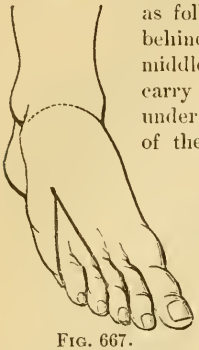


Fig. 667.

9. **Disarticulation at the tarso-metatarsal articulation** is effected as follows: First recognize the exact line of the articulation.

On the inner side of the foot just posterior to the projection on the base of the first metatarsal bone, or one inch anterior to the prominence of the scaphoid, *e* (Fig. 657), on the outer margin of the foot, the finger readily detects the prominence of the posterior part of the metatarsal bone, immediately behind which is the articulation. Care should be taken not to overlook the slight tubercle at the base of the first metatarsal bone and not to mistake it for the prominence of the cuneiform bone.

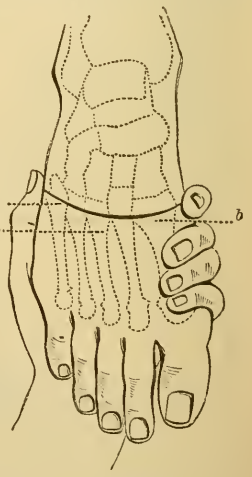


Fig. 668.

Rotate the foot moderately inwards; recognize exactly the line of the articulation — the internal extremity of which is nine lines further forwards than the external — by the rules already laid down; grasp the foot with the left hand, placing the thumb on the outer side of the proximal end of the fifth metatarsal bone, *a* (Fig. 668), and the index finger at the internal extremity of the articulation, *b;* make a semilunar incision with its convexity looking downwards, from without inwards, across the dorsum of the foot, passing about a half an inch below the articulation down to the bones; divide

the dorsal ligaments with the point of the knife, carrying it along the line of the articulation from without inwards, recollecting that the articulation of the second metatarsal lies four lines behind the first and third; this mortise, containing the head of the second metatarsal, is opened by entering the knife between the internal cuneiform and the head of the first, its edge being turned upwards and making an angle of forty-five degrees with the axis of the foot (Fig. 669); now carry the knife up to a right angle, its point traversing the whole of the inner surface of the mortise, in order to insure the division of the interosseous ligament; then divide that on outer surface, depress the metatarsus to separate the articular surfaces, and divide the remaining ligamentous attachments, especially on the plantar aspect of the articulation, so that the knife may be readily carried beneath the heads of the metatarsal bones; cut out a flap somewhat larger at its internal than at its external part, from the sole of the foot (Fig. 670) and extending internally nearly to the base of the great toe; externally it may be of less extent. Do not include the sesamoid bones in the flap.[1]

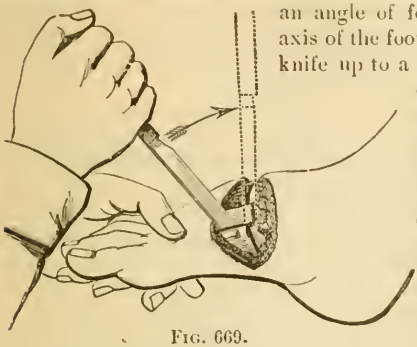


Fig. 669.

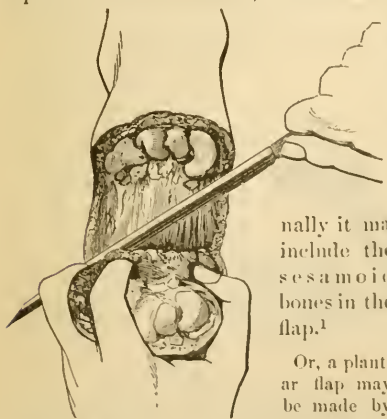


Fig. 670.

Or, a plantar flap may be made by carrying a curved incision from the internal extremity of the dorsal incision (Fig. 671) to the sesamoid bones, then curving forward across the sole of the foot to the junction of the anterior, with the middle third of the fifth metatarsal bone, thence to the beginning of the dorsal incision.

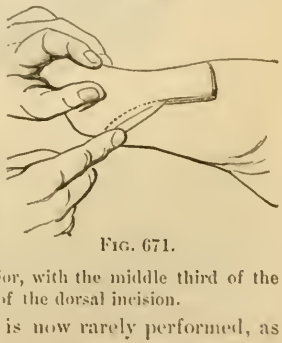


Fig. 671.

10. **Disarticulation, medio-tarsal**,[2] is now rarely performed, as the ankle-joint amputation[3] gives far more satisfactory results.

[1] Lisfranc. [2] Chopart. [3] J. Syme.

The line of articulation is determined as follows: (1.) On the internal side of the foot it lies one inch in front of the internal malleolus; or, the first tuberosity in front of the internal malleolus is that of the scaphoid, and the joint is just behind it. (2.) On the external side it is six lines behind the prominence of the fifth metatarsal bone; or, it is in front of the first tuberosity anterior to the external malleolus, which is on the os calcis. (3.) The centre of the articulation is immediately in front of the head of the astragalus, which is made prominent by extending and abducting the foot. The line of the articulation is changed according as the foot is flexed or extended; when it is flexed, the astragalus and calcaneum are almost on the same line; when extended, the calcaneum is at least three lines in front.

Operate thus: Holding the foot (left) in the left hand, place the thumb on the outside of the joint and the index or medius, on the tuberosity of the scaphoid; make a semilunar incision between these two points, the middle of which is half an inch beyond the articulation; then, passing the heel of the knife under the left thumb, its handle inclined as above, open the joint in the direction pointed out; when the joint is half opened, carry the knife in front of the head of the astragalus, cut the dorsal ligaments without penetrating between the bones; and, lastly, carrying the knife to the other side of the the foot, the heel inclined towards the toes at an angle of forty-five degrees, finish opening the external side of the joint; the dorsal ligaments being thus divided, push the point of the knife under the external and anterior side of the astragalus, with its edge directed forwards, and cut the interosseous ligament in the direction of the articular surface of the calcaneum; the joint is now wide open; carry the knife under the plantar ligaments, and pass it under the bones, grazing them, to cut a sufficient flap (Fig. 672), avoiding the protuberances of the cuboid and scaphoid, and further on, of the first and fifth metatarsal bones; the foot during this time is held in the horizontal position; raise the handle of the knife slightly, to follow more exactly the concavity of the tarsus and metatarsus.

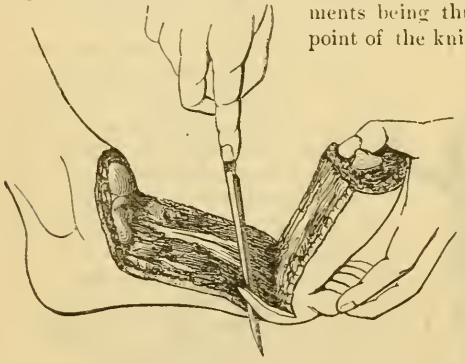


Fig. 672.

11. **Disarticulation of the tarsus under the astragalus** has been practiced, but is not to be preferred to amputation at the ankle joint,[1] except in very rare cases. Operate as follows:[2] —

[1] J. Syme. [2] J. Roux.

Commence an incision on the posterior and external face of the calcaneum, and carry it forward below the external malleolus to a point half an inch anterior to the articulation of the astragalus in front; then carry it to the internal border of the foot, and from thence obliquely backwards across the plantar surface to the point of departure; the flap is thus made from the entire integument of the heel. Or,[1] commence the incision at about the same point, and carry it forward to within one inch of the posterior and internal extremity of the fifth metatarsal bone, thence with a downward curve across the dorsum of the foot to the middle of the internal cuneiform bone, thence across the sole of the foot from within outwards, and from before backwards to the commencement. Or,[2] make the same incision until it reaches the internal border of the foot; then carry it transversely across the plantar surface to the posterior extremity of the fifth metatarsal, then backwards and obliquely upwards along the external surface of the foot to the point of departure (Fig. 673). It may be reversed, passing in the opposite direction, under the foot, from the external to the internal side. In the dissection care should be taken to avoid injuring blood-vessels high in the flap by turning the edge of the knife to the bone.

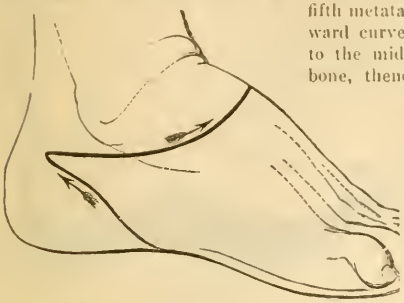


Fig. 673.

12. **Disarticulation at the ankle-joint** with a heel-flap[3] has justly been regarded as one of the greatest improvements in amputation of modern times.[4] Not only is the mortality of this operation very small, but when compared with the stumps made at any other point of the foot, or leg, those made at the ankle-joint have proven eminently superior and gratifying to the patient; they have been less subject to those untoward complications and sequelæ, as ulcers, congestions, necrosis, and chronic tenderness, which impair subsequent usefulness with appropriate and well adapted reparative apparatus.[5]

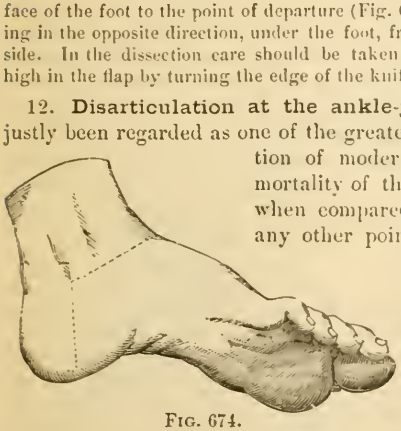


Fig. 674.

The broad articular surface of the lower extremity of the tibia with its internal projection, the internal malleolus, and the large projecting extremity of the fibula, the external malleolus, form a mortise to which the lateral and upper surfaces of the astragalus are so accurately adapted that there can be no lateral

[1] L. Verneuil. [2] E. Nélaton. [3] J. Syme. [4] Sir W. Fergusson. [5] E. D. Hudson.

motion, and disarticulation can only be accomplished when the foot is firmly extended and the knife penetrates the anterior part of the articulation.

Proceed as follows: place the foot at a right angle to the leg; enter the knife at the point of the external malleolus, and carry it directly across the sole of the foot (Fig. 674) to a point opposite, or six lines below the internal malleolus (Fig. 675) the posterior tibial artery divides beneath the internal annular ligament into the internal and external plantar arteries, and if the incision extends to the point of the internal malleolus the vessel may be divided;[1] join the two extremities of this incision by an anterior incision in a direct line over the instep, so that the cicatrix may come well in front[2] (Figs. 674, 675). In dissecting the posterior flap, place the fingers of the left hand upon the heel, while the thumb rests upon the edge of the integuments, and then cut between the nail of the thumb and the tuberosity of the os calcis, so as to avoid lacerating the soft parts, which at the same time are gently but steadily pressed back until the tendo-achillis is exposed and divided. Disarticulate the foot (Fig. 676), and saw off the malleoli obliquely; leave the articular extremity of the tibia uninjured, for it is better not to interfere with the bone if it is healthy.[2]

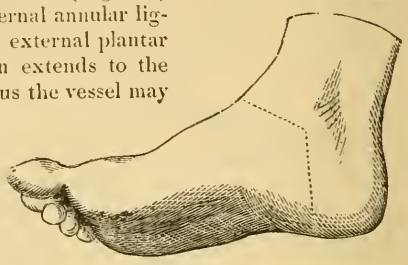


FIG. 675.

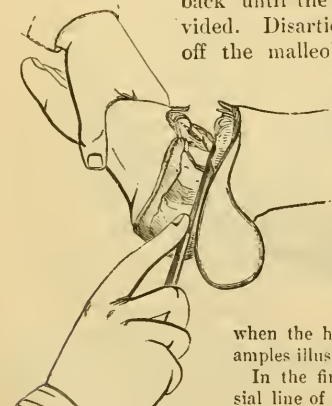


FIG. 676.

There are many methods of modifying the construction of flaps to cover the ends of the tibia and fibula, adapted to the various forms of injury of the soft parts; all coverings, whether from the sole, the lateral surfaces, or from the dorsum of the foot, are useful, and should be preserved for that purpose when the heel-flap is wanting. The following examples illustrate other forms of flap: —

In the first example[3] enter a knife in the mesial line of the posterior aspect of the ankle, on a level with the articulation, carry it downwards obliquely across the tendo-achillis towards the external border of the plantar aspect of the heel, along which it is continued in a semilunar direction; curve the incision across the sole of the foot, and terminate it on the inner side of the ten-

[1] J. A. Wyeth. [2] McLeod. [3] Mackenzie.

don of the tibialis anticus, about an inch in front of the inner malleolus; carry the second incision across the outer aspect of the ankle in a semilunar direction, between the extremities of the first incisions, the convexity of the incision downwards (Fig. 677), and passing half an inch below the external malleolus.

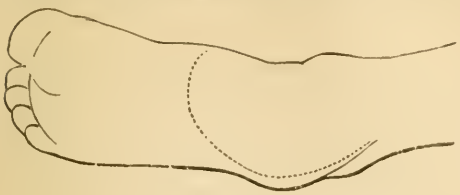


FIG. 677.

Or,[1] make an incision from the junction of the tendo-achillis with the os calcis around the external surface of the foot, immediately below the external malleolus, then carry it inwards towards the internal border, curve forwards and about an inch in front of the ankle-joint (Fig. 678); then pass along the internal border of the foot to the point of departure. The stump (Fig. 679) is very useful. Or,[2] make two horizontal incisions, commencing at the insertion of the tendo-achillis and meeting a little behind the commissure of the toes. Or,[3] make an incision comprising the semi-circumference of the anterior part of the foot, about three fingers' breadth in front of the malleoli, then from the external extremity of the wound carry it horizontally around under the external malleolus to the internal border of the tendo-achillis, which divide; disarticulate, and make a quadrilateral flap from the internal and plantar part of the heel.

FIG. 678.

FIG. 679.

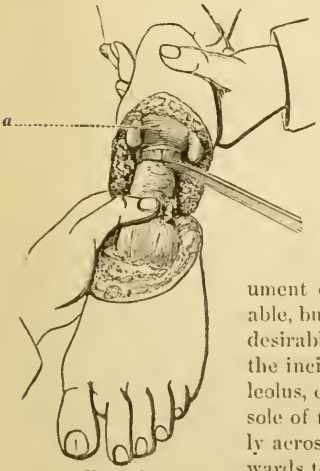


FIG. 680.

13. **Osteoplastic amputation of tibia**[4] provides a covering of the stump consisting of the posterior part of the os calcis, with the integument of the heel. The results are favorable, but the additional length of limb is not desirable for an artificial limb.[5] Commence the incision close in front of the outer malleolus, carry it vertically downwards to the sole of the foot (Fig. 674), then transversely across the sole, and lastly obliquely upwards to the inner malleolus; terminate it a couple of lines anterior to the malleolus (Fig. 675); divide all the soft parts at once quite down to the os

[1] J. Roux. [2] Baudens. [3] C. Sédillot. [4] Pirogoff. [5] E. D. Hudson.

calcis; now connect the outer and inner extremity of this first incision by a second semilunar incision, the convexity of which looks forward, carried a few lines anterior to the tibio-tarsal articulation; cut through all the soft parts at once down to the bones, and then proceed to open the joint from the front, cutting through the lateral ligaments, and thus exarticulate the head of the astragalus (Fig. 680); now place a small narrow amputation saw obliquely upon the os calcis behind the astragalus, and saw through the bone, in the line *c d* (Fig. 681.) Section has been made also in the lines *a e* and *b f*, but the stump is not as well formed. Saw carefully, or the anterior surface of the tendo-achillis, which is only covered by a layer of fat and a thin fibrous sheath, may be injured; raise the short anterior flap from the two malleoli, and make a section of the tibia and fibula just above the articular surfaces; turn this flap forwards, and bring the cut surface of the os calcis in apposition with the cut surface of the tibia; the tendons must not be cut off too near the point where their synovial sheaths are cut through; if cut too short they conceal themselves in the fibrous canal, or, when the limb is moved, slip upwards out of their sheaths.

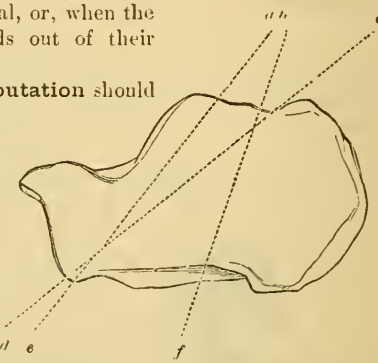


Fig. 681.

14. **Supra-malleolar amputation** should always be preferred to any operation at a higher point, and the flap should be taken from the firmest tissue accessible. The following method gives a good stump: Make an incision from the base of the external malleolus, posteriorly, around the external surface of the foot immediately below the malleolus, and inwards towards the internal border, but curved forwards to a point an inch in front of the ankle-joint (Fig. 682); make a similar incision on the internal surface and unite the two behind by a transverse incision, having a slight convexity downwards; separate the soft parts from the bones, and saw the tibia and fibula at the base of the malleoli, about an inch above the articular surface.

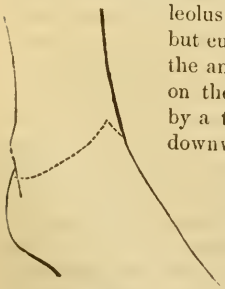


Fig. 682.

15. **The leg amputation** involves new and most important principles both in operative and mechanical surgery. At no other

point is it more necessary to secure a sound and useful stump than in this part. This is due to the incessant use to which it must be applied, and its exposure to injury. But it presents intrinsic difficulties in the application of the ordinary methods of amputation. This is apparent in the development of the muscles of the calf, the tapering form of the lower portion, and the subcutaneous position of the tibia. The circular flap cannot be retracted without dividing it longitudinally; the single posterior flap is of immense size, and is counteracted only by the integument of the anterior part of the leg; the double flap gives a great inequality of flaps; the single external flap leaves the crest of the tibia but slightly covered. The results of amputation of the leg have, in consequence of these conditions, been more unsatisfactory than at any other point. Necrosis of the tibia, conical stumps, ulcerated coverings, and tender cicatrices have been the rule, when the old methods have been preferred. But bilateral flaps of the soft parts and periosteal coverings of the tibia give a firm, compact, and enduring stump.

Sufficient data have now been accumulated to establish the comparative and practical advantages of this method. The largest experience in the critical examination of stumps for the purpose of applying compensative apparatus, has led to the conclusions [1] that the bilateral method gives: (1.) Little liability to exfoliation, necrosis, osteo-myelitis, abscesses, etc. (2.) Healthy tone, circulation, quality, and capacity to the stump, with the least amount of muscular retraction and displacement of covering tissues. (3.) The terminal axis of the stump constitutes a much better basis of support as conditions may exist; and the leverage retained, be it long or short, affords a most important advantage over every other method, both as regards immediate success, and the ultimate superior usefulness of the stump. The most important immediate advantages are (1) a periosteal covering of the cut end of the bone which aids in preventing necrosis and osteo-myelitis, and insures against an adherent cicatrix of the skin; (2) ample and well nourished flaps; (3) complete drainage.

The place of division of the bone may be at any point, but at the lower part of the leg the commencement of the calf is most favorable for a symmetrical stump, and at the upper part, a point two inches below the tubercle of the patella, which permits the knee to be bent, and brings the support upon the condyles of the femur. An amputation at the latter point is indicated whenever the leg is permanently flexed, either at a right or at an acute angle with the thigh. If the amputation must be very close to the joint, disarticulation should be preferred, for the risk to the patient of the knee-joint amputation is no greater than of an amputation of the extreme upper third of the leg, while its practical benefits are much superior, as confirmed by experience.[1] The bilateral flap here recommended should be made as follows: Commence an incision with a large scalpel in the centre of the anterior surface (Fig. 683)

[1] E. D. Hudson.

and carry it downwards along the side of the leg so as to make a slightly curved flap with its convexity below; when the incision passes over the prominent part of the leg towards the posterior surface, incline it upwards until the middle of the limb is reached, where it should be continued directly up to the point at which the bone is to be divided; make a similar incision on the opposite side; these lateral flaps should consist of the skin and superficial fascia; dissect

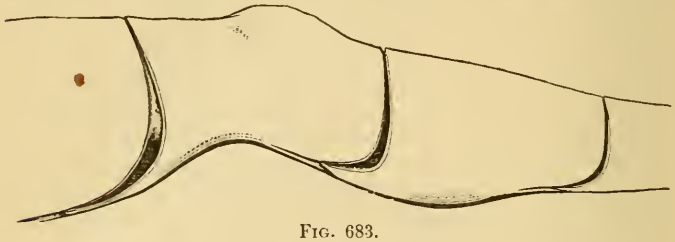


Fig. 683.

them upward to the extent of one inch in the leg and two inches in the thigh; now make a circular division of the muscles to the bone with a long knife; saw the bone or bones at this point, and direct an assistant to seize and hold the extremity firm with strong forceps (Fig. 618); with the periosteal knife, or the thumb nails, which are equally efficient, raise the periosteum from the tibia to the point where the latter is to be cut; divide the bone at the base of the periosteal flap. The periosteum must be cut at its attachments to the bone and should be raised only from the tibia, the fibula being first exsected. The covering thus prepared has the integument externally, the periosteum internally, while the intervening tissues, muscles, vessels, nerves, have not been disturbed in the dissection; the periosteal flap falls like a hood over the end of the bone (Fig. 684), the skin flaps lie in contact without tension, the drainage is direct from the angle of the wound beneath. When cicatrization is complete, the cicatrix lies posterior to the end of the stump; the cushion is freely movable, and the bone does not undergo the usual amount of atrophy.

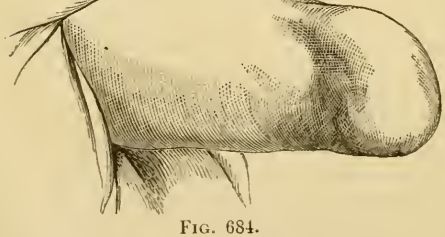


Fig. 684.

16. **The knee joint amputation** is much preferable to amputa-

tion through the thigh; it is quicker, easier, requires simpler instruments, and is attended with less bleeding; there is less shock, less danger of septicæmia and osteo-myelitis as the bone remains sealed; the integuments preserved are, as a rule, better adapted to sustain pressure; there is less risk of injury to flaps from a rough sawn bone; less retraction of muscles; the sustaining power is more quickly acquired; the point of support is broader and better fitted for pressure; from large anastomoses about the joint, the blood supply is more quickly established; the redundant size of the articular head of the femur in time disappears.[1]

The line of the articulation lies internally nine lines above the prominence of the tibia; the lower border of the patella is on a line with the articulation, and externally it is nine lines below the prominence of the external condyle.

There are many methods of operating, but the bilateral flap method is to be preferred for the general reasons given; the joint surface of the bone should not be disturbed unless diseased, and the patella may be left in its place, though it is of no value to the stump.

Operate as follows: Select a large scalpel, and commence an incision about one inch below the tubercle of the tibia, and cut to the bone; carry it downward and forward beyond the curve of the side of the leg, thence inwards and backwards to the middle of the leg, thence upwards to the middle of the popliteal space: repeat this incision upon the opposite side; raise the flap, consisting of all the tissues down to the bone, until the articulation is reached, divide the lateral ligaments, enter the joint, and sever its connections internally and externally.

Care should be taken that the incisions incline moderately forwards, down to the curve of the side of the leg, to secure ample covering for the condyles, and that upon the internal aspect it should have additional fullness for the purpose of insuring sufficient flap for the internal condyle, which is longer and larger than the external.

Fig. 685.

The flaps completely cover the condyles (Fig. 685), and are readily approximated, leaving ample space for direct drainage at the upper angle of the wound; a drain tube may be inserted, if necessary; the flaps are well nourished and union takes place rapidly, giving a well-rounded stump with the cicatrix sunk in the inter-condyloid fossa (Fig. 684).

The practice of dividing the condyles cannot be sustained by any rational hypothesis, nor practiced on any scientific principles; except disease or injury of

[1] McLeod.

the condyles compel their excision, their osseous covering and cartilage investments should be kept inviolate from knife and saw, for, as constituted, they are the strongest, most tolerant, and important supports in the entire body; the inter-condyloid fossa is readily filled with a neatly-shaped elastic pad, of wool felt, even with the convexity of the condyles, and made to extend over them for a cushion, in the adaptation of prothetic apparatus.[1] Equally reprehensible is the method of placing the patella over the fossa with a view to making that a point of support, and also of sawing off the condyles and applying the patella to the cut surface; these and other ingenious experiments are of no practical value.[1]

17. **The thigh** is composed principally of muscular structure, which surrounds the femur in two distinct layers, the superficial and deep; the superficial muscles all spring from the pelvis and go to the leg, and the lower they are cut the more they retract and *vice versa.*

It results that nearly the same length of soft part cover the stump at all points; above, on account of the size of the wound; below, to make up for the increased muscular retraction; the posterior part of the femur being almost uncovered by deep muscles, retraction is stronger there than on the other sides, the more so, as the slightly flexed position of the thigh, by stretching the posterior muscles, favors still more their retraction, and leaves them, when cut, of less real length than the others; the same thing takes place, but to a less degree, on the inside, compared with the outside, the latter only offering muscles adherent to the bone, and the muscles on the inside being also extended by abduction; on this account, after circular amputations, the cicatrix is almost constantly behind and inside.[2]

Observation and experience teach that amputations of the thigh, as ordinarily performed, and ultimately treated with prothetic apparatus, are unnecessarily disabling; but with the bilateral flap and periosteal reserve, and as full length of the femur for leverage as the injury or disease will safely allow, a quality and capacity of stump may be obtained, which, with appropriate, well adapted apparatus, will assure the patient a firm basis of support on a line with the axis of the thigh; ample leverage, and adequate motor power, enables him to balance his weight exclusively on his artificial limb, and to walk without a cane, with ease and gracefulness.[1] If such an operation should prove a secondary success, and ultimately require partial or entire peripheral support in the adaptation of prothetic apparatus, nothing will have been lost, when compared with the past amputations and their results, and, eventually, much may be gained, as has occurred in many cases of the ordinary modes of operation; as a rule, the most perfect success may reasonably be expected of the bilateral variety of operation, and the pleasing and profitable results experienced, in both civil and military surgery, afford guarantees to the mutilated of the greatest possible amount of benefit, with appropriate apparatus.[1] The method of procedure requires the same incision as the operation on the leg already detailed (Fig. 683).

[1] E. D. Hudson. [2] J. F. Malgaigne.

(1.) **Lateral flaps** are made as follows: Introduce the knife in the centre of the limb, directly down to the bone, on one side of which it is passed to the opposite side of the limb and the flap is then formed (Fig. 614), then introduce the knife and make a flap on the opposite side; strongly retract the flaps and saw the bone at the highest point.

(2.) **Antero-posterior flaps** are made thus: Standing at the right side of the limb, grasp the soft parts and bring them forward; transfix the limb, the knife grazing the upper surface of the bone and make an anterior flap (Fig. 614); reintroduce the knife and, passing it under the bone, make a posterior flap longer than the anterior (Fig 614), to compensate for the greater retraction; complete the operation, as in the lateral flap method. Another method is as follows: standing at the right side of the limb, grasp the thigh with the left hand, placing the fingers and thumb on opposite points, apply the heel of a long amputating knife on the further side of the limb at the ends of the fingers, and drawing it in a semi-circular direction over the limb to the end of the thumb, dividing by this single sweep all the soft parts down to the bone; without removing the knife, withdraw it sufficiently to enter the point at the angle of the wound, and transfix the limb, passing under the bone to the angle of the wound on the opposite side; cut a flap of the requisite length from the posterior part of the thigh.

18. **The hip-joint** is formed by the head of the femur and the acetabulum, into which it is received: its ligaments are the round ligament, which attaches the head of the bone to the bottom of the cavity, and the capsular ligament surrounding the joint; it is deeply situated under thick and powerful muscles, and can be felt only on the anterior part; it must be recollected that the plane of the margin of the acetabulum inclines downwards and forwards, projecting more posteriorly than anteriorly; the arteries are the femoral, the obturator, the ischiatic, and external and internal circumflex. The following are anatomical guides to the joint: —

(1.) The anterior inferior spinous process of the ilium is three quarters of an inch above the superior margin of the acetabulum; the anterior superior spinous process is about an inch and three quarters above the same point, and three quarters of an inch to its outer side. (2.) The anterior border of the acetabulum is from an inch to an inch and a quarter to the outside of the spine of the pubes. (3.) The axis of the horizontal ramus of the pubes, extended by an imaginary line, crosses the acetabulum at the junction of its superior with its middle third. (4.) The superior border of the trochanter major is on a level with the upper third of the cavity of the joint.

Amputation may be performed by the single flap, anterior or internal; the double flap, lateral, or antero-posterior; the oval; and the circular. These different methods have been almost indefinitely modified. Hæmorrhage should be prevented by the application of a tourniquet[1] or a compress[2] to the abdominal aorta. The common iliac may be compressed through the rectum by means of a shaft having a curved extremity, which may be hooked over the brim of the pelvis.[3] The shock due to the loss of the blood in the limb may

[1] J. Lister. [2] J. Spence. [3] R. Davy.

be prevented by first applying the elastic bandage to the limb, and fixing the tube just below the line of incision.[1] The operation should always be performed with antiseptic precautions, and provision for thorough drainage should be made.

1. **The single flap** method admits of very rapid performance[2] (Fig. 686). The following are the several steps: The patient lying upon the edge of the table, the hip projecting, the artery is compressed upon the horizontal branch of the pubes; the operator then takes a position on the outside of the limb (the left), which is separated from the other and slightly flexed on the pelvis, and raising the soft parts, which cover the anterior face of the limb, enters a very long double-bladed knife midway between the great trochanter and the anterior superior spine of the ilium, directing it at first slightly from below upwards, and from without inwards, A, C, so as to reach the head of the femur, and open the capsule of the joint; he now elevates the handle, and carries the knife in the direction A, B, the point emerging about an inch below and in front of the tuberosity of the ischium; the knife is then carried downwards along the anterior surface of the bone, and a large semilunar flap is made, extending nearly half the length of the thigh, or six inches; care should be taken that the flap is as long on the inside as on the outside; an assistant raises the flap, *a*, *e*, at the same time compressing the artery which it contains; the knife is now applied to the capsule, which is divided close to the acetabulum, as if about to cut across the middle of the head of the femur, D, and at least half of its circumference; the limb is then abducted to luxate the head of the bone, the knife passed behind it, and the soft parts on the posterior portion of the limb divided as in the circular operation.

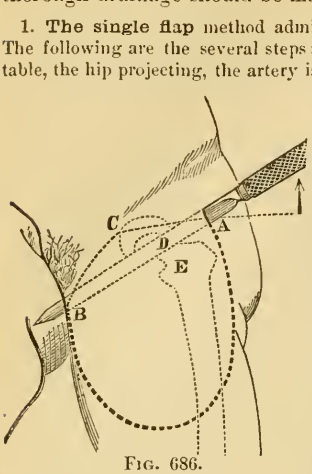


FIG. 686.

2. **Double antero-posterior flaps** are made thus[3] (Fig. 687): Standing on the outside of the limb, insert the point of a long catling about midway between the anterior superior spinous process of the ilium and trochanter major, keeping it rather nearer the former than the latter; then run it across the fore part of the neck of the bone, and push it through the skin on the opposite side, about two or three inches from the anus; next, carry it downwards and forwards, so as to cut a flap from the anterior aspect of the thigh, about four to six inches in length. When the blade is entered, the

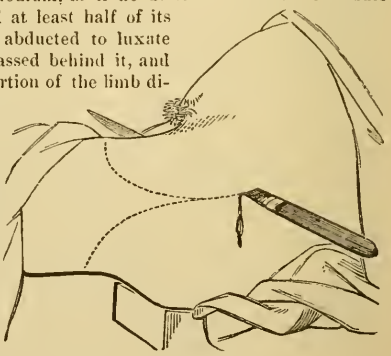


FIG. 687.

[1] E. Mason. [2] Malgaigne; Guérin. [3] Sir W. Fergusson.

limb should be held up, and even slightly bent at the joint: the instrument will then pass along more readily than if all the textures were thrown on the stretch; moreover, there is greater certainty of passing it behind the main vessels, and even dividing some of the fibres, if not the whole, of the iliacus internus and psoas muscles. As the knife is carried downwards, the assistant, who stands behind the operator, should slip his fingers into the wound and carry them sufficiently far across to enable him to grasp the femoral artery between them and the thumb; this he may do from the inside or outside at will, and with the right or left hand, as may be most convenient, the same grasp enabling him to raise the flap as soon as it is completed. The flap being raised, the point of the knife should then be struck against the head of the bone, so as to divide the anterior part of the capsular ligament and any textures in this situation which may not have been included in the flap. To facilitate this part of the operation, the knee should be forcibly depressed by the assistant who holds it; the head of the bone will thus be caused to start from its socket, and, if the round ligament is not ruptured by the force, a slight touch with the edge of the knife will cause it to give way. At this period, depression being no longer required, the assistant should bring the head of the femur a little forwards, to allow the knife to be slipped over and behind it, and when it is in the position represented in the design, it should then be carried downwards and backwards, so as to form a flap somewhat longer than that in front, the last cut completing the separation of the limb.

3. **Double lateral flaps**[1] (Fig. 688) are made as follows: The patient must be laid upon his back with the tuberosities of the ischia projecting slightly beyond the edge of the bed, and the limb held in a position between abduction and adduction. Then, having determined by the anatomical rules laid down the anterior and external side of the articulation, the operator holding perpendicularly a long double-edged knife introduces it at this point with its lower edge looking downwards towards the great trochanter. As the point of the knife enters it should be carried around the head of the femur, on its outer side, whilst its handle is inclined upwards and outwards, and pushed steadily on in this direction so that it perforates the integuments a few lines below the tuberosity of the ischium. While this is being done an assistant grasps the tissues over the trochanter and carries them outwards, in order to assist in the formation of the external flap, and the knife is carried downwards and outwards with a slightly sawing motion, around the great trochanter, and along the femur, cutting out a flap from three to four inches in length, *a*, *b*, *c*. The first flap being thus made, the operator grasping the tissues on the inside of the thigh and carrying them inwards, introduces the knife below the head of the femur, and on the inner side of its neck, holding it in a perpendicular position. As it enters, the point of the knife should pass around the neck of the femur and come out at the lower angle of the wound already made, without coming in contact with the bones of the pelvis; it is then carried downwards along the femur, and

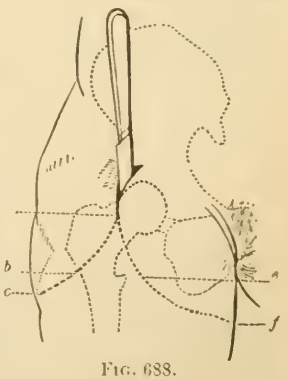


FIG. 688.

[1] Lisfranc's.

avoiding the lesser trochanter, so as to make an internal flap of the same length as the external, *e*, *f*. The flaps being drawn aside by the assistants, and the arteries tied, the surgeon grasps the femur with his left hand, and, holding the knife perpendicularly on the inner side of the head of the bone, cuts the capsular ligament without attempting to penetrate the articulation. The joint being opened, the disarticulation is concluded by cutting the fibrous and muscular tissues which remain.

Care should be taken that the incisions incline moderately forwards down to the curve of the side of the leg, to secure ample covering for the condyles, and that upon the internal aspect it should have additional fullness for the purpose of giving sufficient flap for the internal condyle, which is longer and larger than the external.

4. **Double Flaps, long anterior and short posterior,** give good results.[1] The surgeon enters the point of the knife between the spine of the ilium and the trochanter major, and carries it across the thigh, as near as may be to the head and neck of the femur, until the point appears on the inside near the scrotum, which should have been previously drawn away. The knife is to cut slowly downwards, to make a flap, under which an assistant inserts his four fingers, in order to be able to grasp the flap and aid in compressing the principal artery, as the operator completes the flap, which should be a large one. The assistant holding up the flap, the surgeon cuts the attachment of the glutens medius muscle from the upper edge of the trochanter, if it has not been already done, opens the capsular ligament of the joint, and divides the ligamentum teres. The head of the bone can then be readily withdrawn from the acetabulum. The knife, being placed behind the head of the bone and the trochanter, should be carried obliquely downwards and backwards, so as to form a shorter flap behind than was made before.

5. **The oval operation** is as follows[2] (Fig. 689): Standing on the inside, commence the first incision three or four inches directly below the anterior-spinous process of the ilium, *a*, carry it across the thigh through the integuments, inwards and backwards, in an oblique direction, at an equal distance from the tuberosity of the ischium to nearly opposite the spot where the incision commenced, *c*; carry it upwards with a gentle curve behind the trochanter, until it meets with the commencement of the first, *b*; retract the integuments, including the fascia; cut the three gluteal muscles through to the bone; the knife being then placed close to the retracted integuments, cut through everything on the anterior part and inside of the thigh. The femoral or other large artery should then be drawn out by a tenaculum or spring forceps, and tied. The capsular ligament being well opened, and the ligamentum teres divided, pass the knife behind the head of the bone thus dislocated, and cut its way out, care being taken not to have too large a quantity of muscle on the under part, or the integuments will not cover the wound, under which circumstances a sufficient portion of muscular fibre must be cut away.

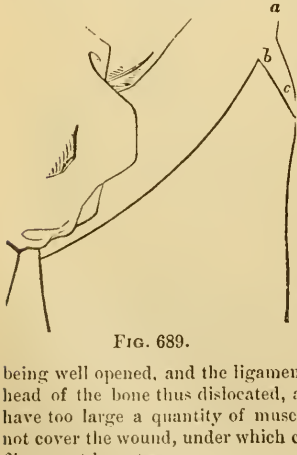


FIG. 689.

[1] C. Heath. [2] C. J. Guthrie.

6. **The circular method** has recently been preferred to other methods.[1] The first incision should be made about six inches below the anterior superior spine of the ilium; the skin and superficial fascia being turned back, the second incision should be made through the muscles; these being retracted, the next incision may expose the bone; the joint is now opened, the knife passed behind the head, and the soft parts severed.

CHAPTER LIX.

DEFORMITIES.

DEFORMITIES of the extremities occur as congenital and acquired conditions.

I. PHALANGES.

1. **A supernumerary digit**[2] appears in many forms, and should be treated according to the peculiarities. (1.) If it is attached loosely or by a narrow pedicle, divide the pedicle close to its point of attachment to the skin so that no remains may be left; hæmorrhage must be carefully suppressed. (2.) If it is more developed, and articulates with the sides of a metacarpal or phalangeal bone, which is common to it and another digit, operate early, and so arrange the incisions as to leave as small a cicatrix as possible. (3.) In cases where the additional digit is connected to the head of a phalangeal or metacarpal bone, the removal is likely to involve the opening of the joint of the adjacent phalanx; removal is advisable only in case the additional phalanx impairs the function of the other. (4.) If the digit is fully developed, having its own phalangeal and metacarpal bone, removal is rarely advisable, but if required, they must be taken away so as to leave as little deformity and impairment as possible.

2. **The union of digits, webbed**, may be congenital, when it is generally symmetrical; or the result of injuries and burns. The uniting medium may be the skin only, or the skin and deeper tissues, and even the bone. The two apposing digits may be united throughout their entire length, or only in part. Webbed toes does not require treatment. When the union is partial, and does not involve the interspace at the cleft, divide the connecting tissue, and maintain the fingers apart, until cicatrization is complete. When the union at the cleft is complete there is great difficulty in preventing reunion after division. Introduce a seton at the base of the cleft[3] (Fig. 690) and allow it to remain until the opening becomes permanent, when the remainder of the web may be divided; India-rubber tubing introduced at the same point and tied to a band around the wrist makes a good seton.

[1] E. Mason. [2] T. Annandale. [3] J. Lister.

Or, make two flaps of the web, anterior-and posterior,[1] but reversed; for the posterior, make an incision along the dorsal aspect of one finger the length of the web, and transverse incisions at either extremity to the middle of the dorsum of the other finger; repeat the operation on the palmar surface, but make the longitudinal incision along the palmar surface of the finger which forms the base of the posterior flap; dissect the two flaps and turn them back; separate the fingers which now have each a flap, one attached upon the dorsal and the other upon the palmar surface; apply the flaps to their respective fingers; the union of these flaps effectually separates the fingers. Or, separate the web along one finger, unite its margins, and thus form a flap for the opposed digit; close the wound left upon the other finger by a piece of skin transplanted from the hip, the hand being bound to the part until adhesion has taken place.[2]

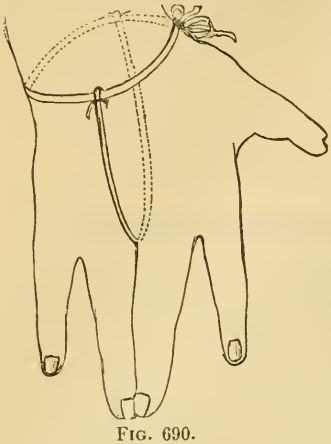


FIG. 690.

3. **Flexion of the phalangeal joints**, so as to permanently distort the fingers, may be congenital or acquired. When the deformity can be overcome by division of contracted tendons or fascia, this operation must be performed and suitable splints applied. If, however, the conditions are unfavorable to tenotomy, the affected joint should be exsected.[3] In extreme cases amputation is the only successful remedy.[4]

4. **Distortion of a phalanx** may be caused by arthritis, or, in the case of the great toe, by a bunion. The position in most cases may be properly rectified by excision,[5] but, in extreme cases, amputation may be the preferable operation.

II. MAL-POSITION AFTER FRACTURE.

When union takes place with such distortion as to impair the usefulness of the limb, the deformity must be rectified.

1. **Extension and compression** may be made in recent cases; immediate straightening may follow, with the right hand grasping and extending the extremity, while, with the other, firm compression is made upon the convex portion; to obtain more gradual results apply a weight and pulley to the extremity and bind a straight splint on the concave side with as much tightness as the patient will bear.

2. **Refracture** must be effected if the first method fail. Proceed as follows: The patient being under an anæsthetic, bend the limb

[1] J. K. Rodgers. [2] B. Brodhurst. [3] A. C. Post. [4] T. Annandale. [5] F. H. Hamilton.

over the knee,[1] or over the edge of a table or board; or, the limb being well fixed by assistants, the weight of the body, or even of two persons, may be thrown upon it.[2] When the fracture occurs, a rotary motion should be given to the lower fragment.[2] If these means fail, resort may be had to the osteoclast, or to osteotomy. The osteoclast has frequently been used,[3] but there has been a lack of precision as to the point of fracture. This defect has been overcome and a transverse fracture may be produced at any selected point with ease, certainty, and freedom from after-complication.

(1.) **The osteoclast**, as perfected,[4] consists of a U-shaped bar of iron (Fig. 691, 1, 2) three fourths of an inch square, on one ramus of which is placed a hard rubber pad one and three fourths inches wide, and curved to fit the rounded surface of the thigh. On the side opposite to this pad a V-shaped bar of iron (3) is fitted under the ramus, and controlled by two thumb-screws (4, 4) which pass through the ramus itself (Fig. 691). A strong piece of hard wood (5, 6) is used for the fracturing lever. At the lower end of the lever a pad (6), similar to the one just described, is firmly fastened and is intended to rest over the trochanter major. The pad resting over the trochanter major, the body of the lever passes under the V-shaped piece, extends along the femur and parallel to it, and has fitted into it, at the distal extremity, female portions of a screw, through which a threaded rod (12) works as its point rests in a socket, upon the outer side of a free pad (9, 10), also rubber-lined, that is placed in contact with the distal extremity of the femur. The threaded rod terminates in a crank-like handle (13, 14, 15, 16). The instrument is placed so as to avoid, as much as possible, injurious pressure on the large vessels and the larger masses of muscles. The regulating screws (4, 4) are then adjusted until the three pads mentioned sustain a uniform and firm pressure, when by a few rapid turns of the crank the fracture is produced beneath the pad (1).

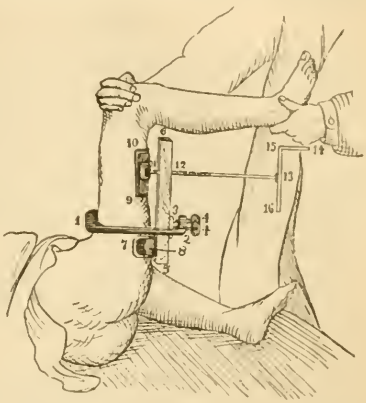


FIG. 691.

(2.) **Osteotomy**, section of bone, though creating all the conditions of a compound fracture, has proved an entirely safe and successful procedure when antiseptic precautions are used. The operation may be performed with a saw, or a chisel and mallet. The saw[5] is three-eighths of an inch in width, with one inch and a half cutting edge at the end of a small shank three inches in length. Make the puncture down to the bone with a long tenotomy knife; divide the muscles, and open the capsule freely: on withdrawing the knife, pass the saw along the track made, down to the bone, and saw through it; straighten the limb and close the wound firmly with suture, or adhesive plaster; apply a

[1] S. D. Gross. [2] F. C. Skey. [3] Rizzoli. [4] C. F. Taylor. [5] W. Adams.

splint or a gypsum dressing. When the chisel[1] is used, select a carver's cold chisel,[2] three-eighths of an inch in width at the cutting edge, which is widest, and three inches and a half long in the shaft; make an incison by penetration with a pointed knife, double-edged, down to and at right angles with the bone, dividing the periosteum; introduce the chisel by the side of the knife, and at right angles to the axis of the shaft of the femur; with a light wooden mallet drive the chisel well into the bone, then partially withdraw, and again drive it onwards, inclined somewhat obliquely forwards, and then backwards, so as to divide the bone in the rest of its thickness; finally, gradually and carefully extend the limb, breaking any small portion which may have escaped the chisel. The incision of the skin should be a little to one side of the point where the bone is divided to render the deep wound subcutaneous. The wound may be closed by suture or adhesive strip, and a splint should be applied, or gypsum dressing.

III. DISTORTIONS OF THE FEET.

Distortions of the feet may be due to spasmodic action of one class of muscles, the antagonizing muscles acting normally, or to paralysis of one class, the opposing muscles being healthy. Careful examination of each case will determine whether spasm or paralysis is the cause; but, in general, congenital cases are caused by spasm, and non-congenital by paralysis. The general rule of treatment is to endeavor to overcome those deformities, by appliances, which readily yield to manipulation, and are caused by paralysis, and to divide contracted tendons in those which do not yield readily, and are caused by spasm. The objects of treatment are the restoration of form and function, and the means to be employed are physiological, mechanical, and operative.

The scientific treatment of severe deformities can only be accomplished by a judicious combination of these three methods, and many of the failures are due to the want of this combination of principles too frequently considered antagonistic to each other.[3]

Selecting talipes varus, the most frequent example of club-foot, the rules of treatment as regards the adoption of the several methods are as follows:[3] If no obstacle exists to the perfect restoration of form by gentle application of force, the defect may be remedied by the manipulations of the nurse, aided, in more marked cases, if necessary, by simple mechanical appliances, as rubber plaster, a boot with springs. (2.) If the foot can be nearly but not quite restored to its natural form by the hand, the heel remaining somewhat elevated so as to limit or prevent flexion at the ankle-joint, tenotomy is justifiable, as it greatly hastens the cure. (3.) In more severe grades, tenotomy is indispensably necessary; these cases are recognized by the following features, namely, the foot cannot be fully everted or brought to a straight line with the leg by manipulation,

[1] R. Volkman. [2] C. F. Maunder. [3] W. Adams.

and in the attempt to effect this the inner malleolus does not become prominent; (2) the os calcis either cannot be depressed at all, or only to a slight degree, so that after the partial eversion of the foot little or no flexion at the ankle-joint can be obtained.[1]

The following summary of principles of treatment of congenital clubfoot deserve attention:[2] (1.) Whether the case promises favorably for mechanical treatment only, or needs, as the majority of cases do need, operative interference, commence the treatment as soon after birth as practicable. (2.) Reduce the distortion from the state of a compound one (varus) to the simpler form (equinus), by first curing the inversion of the foot, and the tendency to involution of the sole. (3.) Avoid the slightest undue pressure upon prominent points of the leg and foot, by careful padding of the hollow parts, and by using only gentle pressure with any bandage; avoid obstruction of the returning blood from the limb. (4.) Remove splint and bandage daily, practice gentle movements of the foot in the desired direction, endeavor to prevent the part remaining for an instant unsupported and liable to fall back into the deformed position, until it is found that the foot, on removal of the bandage, retains a perfectly good position and flexibility. (5.) Never permit the child to be placed on the feet, or to walk until the form and movements are complete, whatever may be the age of the patient. The only apparatus necessary to carry out this treatment is a splint of tin or pasteboard so adapted to the external parts as to leave a space between the foot and splint when bandages are applied, or rubber plaster applied to the anterior part of the foot, and passing up the external surface of the leg to which it is fastened.

1. **Talipes equinus** (Fig. 692) is usually non-congenital. The treatment is operative and mechanical. The tendo-achillis and plantaris may alone require division, or, in addition, the plantar fascia must be cut, as when the arch of the foot is strongly contracted; the foot should usually be brought into position at once and retained by splints or the gypsum bandage. At the end of a week the shoe should be applied (Fig. 693).

Fig. 692.

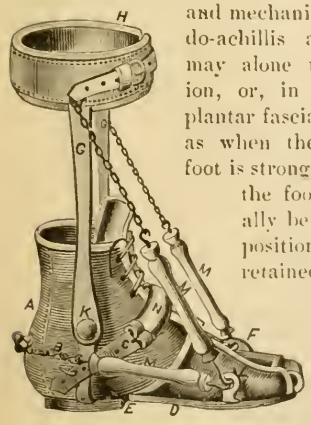


Fig. 693.[3]

Its construction and modes of action are as follows: a cushioned iron cap to receive the heel, the leather covering of which is carried over the instep and ankle, and fastened by lacing; elastic tubing, N, to go in front of the ankle-joint, to further secure the heel in position, and fasten-

[1] W. Adams. [2] W. J. Little. [3] G. Tiemann & Co.

ing at C an iron hook on outside of heel cap; sole of shoe, D, cushioned, and laced securely in front of the medio-tarsal articulation; ball and socket joint, E, connecting sole with heel; elevated plate of iron, F, properly cushioned, to make pressure against base of first metatarsal bone; steel bars, G, connecting the shoe with strap, H, to go around the calf; joint K, opposite the ankle; stationary hooks, L, opposite the toes, for attaching the India-rubber muscles, M M M. These India-rubber tubes have chains attached, and are for the purpose of making flexion and eversion.

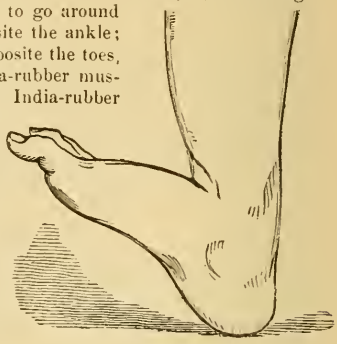


Fig. 695.

Or, the following more simple apparatus may be used: the sole of the strong leather shoe is of metal, with a joint near the heel, allowing lateral motion; a durable spiral spring, *a* (Fig. 694), draws the foot outward by a constant, elastic, and easy traction; this pressure is increased or decreased at will, by fastening the spring in a series of sockets *c*. The single outside upright steel bar, with joints at the ankle, is fastened round the limb below the knee-joint, and so constructed that the screw at the ankle-joint forces the foot flat upon the floor, the foot in almost all cases being turned under as indicated (Fig. 692); the spiral spring, *d*, attached to a catgut cord and fastened near the toes upon the outside of the foot, elevates the toes and stretches the tendo-achillis, thus drawing the foot to its natural position.

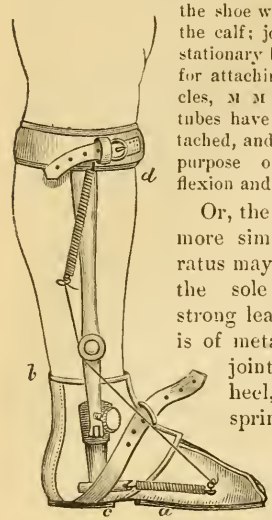


Fig. 694.[1]

2. **Talipes calcaneus** (Fig. 695) is both a congenital and non-congenital affection. In congenital cases the deformity is of the simplest kind, the position of the foot being an exaggerated degree of flexion. In ordinary cases the treatment required is passive exercise and the use of a soft padded splint applied in front of the leg and foot. In severe cases, with much contraction of the anterior muscles, the tendons of the tibialis anticus, extensor proprius pollicis, extensor longus digitorum, and peroneus tertius should be divided.

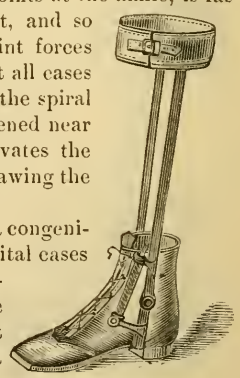


Fig. 696.[1]

[1] G. Tiemann & Co.

The apparatus has a steel spiral spring, placed on a pivot and playing between brackets of the leg and ankle stem, to depress the front part of the foot by extension; there is not so much danger of falling with this apparatus, when descending stairs. Or, instead of the spring, there may be an elastic band attached to the heel of the shoe below, and to the ring above, which constantly tends to elevate the heel.

Non-congenital calcaneus is usually the result of infantile paralysis, and, as a consequence, tenotomy is seldom required; palliative treatment alone must be attempted by the application of a proper shoe.

3. **Talipes varus.**[1] in its severe form, has the following external characters (Fig. 697), namely, the anterior portion of the foot is turned inwards, forming a right angle, the sole looks directly backwards and the dorsum forwards; the inner border looks directly upwards, and the outer directly downwards. The first stage of treatment consists in correcting the varus by turning the foot outward into a straight position, or by bringing the sole squarely downwards; the second stage consists in overcoming the elevation of the heel, equinus, if that exist. If the foot can be brought around nearly straight with comparative ease, the effort should be made by manipulation and bandaging to correct the deformity. This may be effected by many methods: (1.) Apply a strip of adhesive plaster around the anterior part of the foot, commencing on the dorsum and passing around the inside, then across the sole to the outside, and then, while the foot is turned strongly outward, up the outside of the leg to the knee; over this dressing apply a roller bandage; repeat the dressing every second day. (2.) Apply a splint adapted to the outside of the limb, with a foot-piece at an angle with the foot, and, beginning at the upper part, bandage the leg and foot to the splint (Fig. 698); change the dressing every second day, giving to the foot strong traction externally.[2] (3.) Give the patient chloroform, and, after forcing the foot outwards fifteen minutes, apply a gypsum bandage; repeat the dressing weekly.[3] In cases which require tenotomy, divide the tibialis anticus and posticus, and if necessary, also the tendo-achillis

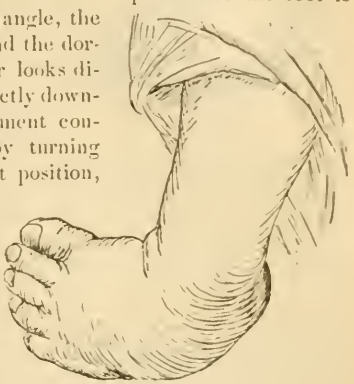


Fig. 697.

Fig. 698.

[1] W. Adams. [2] W. J. Little. [3] A. Ogston.

and flexor longus digitorum; after the healing of the wounds, apply the clubfoot shoe. A shoe has been devised [1] which combines extension of the foot with eversion, and excellent results have followed its use.

4. **Talipes valgus** [2] (Fig. 699) is rarely congenital. Marked cases, without rigid muscular contraction, may be cured mechanically in a few months without tenotomy; but severe cases demand a combination of operative, mechanical, and physiological means. The tendons requiring division in the slighter cases are the peronei and extensor longus, and the tendo-achillis, if involved; in very severe cases, the tibialis anticus and the extensor pollicis must also be divided. The mechanical treatment of slight cases in which the tendo-achillis is not divided is as follows: A convex pad of vulcanized India-rubber is placed inside of the boot in the normal situation of the arch of the foot which it is intended to support; it should extend half way across the sole of the foot, and rise on the inner side so as to support the navicular bone; the heel should be raised on the inner side about a quarter of an inch so as to twist the foot inwards and throw the weight on the outer side. In more severe cases it is necessary to add a steel support, attached to the outer side of the boot and carried up to the calf of the leg, where it is connected with a semicircular steel plate, and a strap which encircles the leg; a free joint should correspond with the ankle, and a leather strap attached to the inner side of the boot should pass across the ankle joint and buckle outside the steel support. In the most severe cases, after tenotomy is performed, a shoe must be applied which effectually brings the foot by degrees into position.

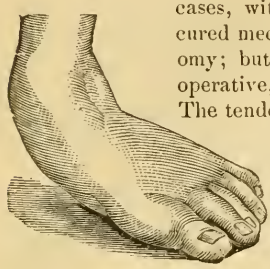


Fig. 699.

IV. ANCHYLOSIS.

Anchylosis,[3] stiffness of a joint, is due to pathological changes in and around an articulation, as follows: (1.) Cicatricial adhesions between adjacent surfaces of a joint. (2.) Cicatricial shrinkages of the articular capsule, of the accessory ligaments, and even of the semilunar cartilages. (3.) Adhesions of the walls of the synovial sacs. (4.) Bony deposits in the joint on the articular surfaces of the bones implicated. (5.) Loss of substance from caries, so that the epiphyses stand obliquely to each other and cannot be brought into position. These changes are usually the result of disease, but a healthy joint will finally become anchylosed if kept immovable for

[1] N. M. Shaffer. [2] W. Adams. [3] T. Billroth.

years, for the secretion of synovia is arrested, the synovial membrane becomes dry and tough, the cartilages become filamentary, and the entire apparatus finally changes to a cicatricial connective tissue which may ossify. When the rigidity is due to bony formations, it is true anchylosis, and when caused by fibrous structures it is false anchylosis. Generally, where true anchylosis exists, the sensation on grasping the limb above and below the joint, and on endeavoring to move one part on the other, is unmistakeable; this sensation of solidity is never felt when the adhesions are fibrous. As bony anchylosis is the exception, and fibrous adhesions infinitely more common, the full effect of chloroform should always be obtained before anchylosis is pronounced to be bony. Immobility alone is not proof of true anchylosis, for it frequently exists where the adhesions are fibrous; and even where the full effect of chloroform has been obtained, so that all muscular influence has been removed, immobility sometimes remains as great as before. In the treatment of fibrous anchylosis, when the contraction can be entirely overcome under the influence of an anæsthetic, rupture the adhesions and place the limb in a condition of perfect rest, and apply ice-bags to avoid inflammation. If the parts do not yield, remove such impediments to extension as are offered by contracted muscles and by tense fasciæ, by dividing subcutaneously all such structures as are likely to interfere with the extending process.

Cicatrices and adhesions should be previously subcutaneously divided, so that unequal pressure may as far as is possible be removed during the act of extension, and especially from those weakest points in the neighborhood of cicatrices; should the continuity of the integument be endangered by the extension which may be necessary for the replacement of the articular surfaces, it is preferable to complete this replacement on a second occasion rather than to risk the smallest rent of the skin; those cases are attended with the greatest success where the adhesions are ruptured on the application of moderate force and which yield with a single snap, where the skin is in no measure endangered, where the adhesions are extra-capsular, and where the integrity of the joint is so far preserved that there is no tendency to dislocation.[1] When, however, in consequence of partial dislocation, of extensive adhesions within the joint, or from other cause, considerable force has to be employed, be careful as to the direction and extent of the force used, especially when cicatrices exist, that the integument may not, by a violent movement of the limb, be ruptured; with care this accident will never occur; as it is not always possible to destroy all the existing adhesions without endangering the continuity of the integuments, it is more prudent, when great tension has been induced and rupture of the skin appears to be imminent, to remit extension, and to complete the operation on a future occasion.[1] After the subsidence of any inflammation or tenderness which may have been induced, the remaining adhesions will probably yield to gentle pressure, or on the application of slight force.[1] The adhesions having been ruptured, no further motion or examination of the joint should be permitted.[1]

[1] B. Brodhurst.

1. **The phalangeal joints** [1] are often distorted by disease, the extensor muscles giving the direction to the displacement more frequently than elsewhere; the extensors may prevail over one phalanx and the flexors over another. In the treatment, section of tendons is rarely required; the bent joint can usually be straightened under an anæsthetic with the greatest ease, and the straight joints resume their natural posture without external aid. The straightened finger should be put up in the straight position, and passive motion must be resorted to and continued until free motion is secured.

If anchylosis is a necessity, the bent position of a finger, so as to touch the thumb, is most useful.[2]

2. **The wrist-joint** is rarely anchylosed without more or less implication of the carpal joints; when separately anchylosed its motions are so largely supplemented by the carpal joints that its functions are not impaired to such an extent as to justify other than the most moderate efforts to overcome the stiffness. The patient being under an anæsthetic, attempt flexion and extension, carefully avoiding too great strain of the carpal joints. The after-treatment requires rest, with applications of ice, for two or three days, and then passive motion.

3. **The elbow-joint** [1] is frequently anchylosed in a more or less straight position which seriously diminishes the usefulness of the hand. In false anchylosis, give an anæsthetic, and secure rotation of the forearm if possible; next, first move the arm in the direction opposite to that which is especially to be obtained, that is, if the joint is too much flexed, flex the forearm still more; and if too straight, extend it; when the joint is over-flexed, grasp it in such a manner as to keep the thumb over the head of the radius and biceps tendon; during the act of extension, make a number of jerky actions, rather than apply a steady force; if the tendon of the biceps becomes perfectly tense, and the head of the radius does not follow the movement, the effort must be discontinued or the tendon be divided to avoid dislocation of the radius. In flexing an over-straight arm, greater power is secured by placing the knee in the bend of the elbow, care being taken not to use such pressure as will endanger vessels and nerves. If the triceps resist much, in a person under eighteen, or even more, if development is retarded, the muscle should be divided. The after-treatment requires rest and ice-bags until the danger of inflammation is passed, when passive motion must be perseveringly made.

If the anchylosis is true, or bony, exsection may be practiced. The steps of the operation are the same as for caries, except that a tri-

[1] R. Barwell. [2] T. Bryant.

angular piece of bone must be removed at the seat of the old articulation. Passive motion must be early practiced, to prevent union.

4. **The shoulder-joint**[1] is rarely affected with true anchylosis; it is difficult of diagnosis, owing to the mobility of the scapula. Proceed as follows: the patient sitting on the floor, or on a low stool, stand behind and fix the shoulder with the thumb of one hand on the acromion and the fingers in the axilla; now lift the arm away from the side without force, and in a plane parallel with that of the chest; if there is any motion it will be detected. To obtain motion, give an anæsthetic, and place the patient on the opposite side; bend the elbow at right angles, and, using the forearm as a lever, grasp the upper arm as high as possible, and rotate the humerus, but no further outwards than is normal; when this movement is free, place the arm in front of the body, across the chest, till the elbow lies in front of the ensiform cartilage, and rotate the humerus a little; then place the arm behind the trunk until the elbow lies just above the sacro-iliac synchrondosis, but do not rotate; having loosened the adhesions, to a certain degree, again grasp the shoulder as at first, lift the arm as far as it will go without force, and commence circumduction in as large a circle as possible; the arm should be brought to at least a right angle and a half with the body, and even more elevation is desirable; considerable extension should be made during these manœuvers. Require rest in the recumbent position for two or three days, and apply ice-bags; as the tenderness subsides, commence gentle passive motion. If the anchylosis cannot be overcome, the free movements of the scapula eventually give great freedom of motion to the arm.[2]

5. **The knee-joint** may be anchylosed at any angle, but that which is most useful is the nearly straight position, which should be secured, if possible, when bony anchylosis is impending. If the angle is greater, the question of an operation should be decided as follows, in fibrous anchylosis: (1.) If the limb be in such posture as to permit tolerable locomotion, it is wrong to break down an anchylosis large, old, and inveterate enough to require more than a moderate exertion of force; (2.) If the limb be in a position which renders locomotion hardly tolerable, it is justifiable to use a great amount of force to break down the anchylosis and restore the limb to position.[1] The operation of forcibly breaking the fibrous structures about the joint should be performed as follows: The patient being fully anæsthetized, place him in a prone position with his chest and face elevated; bring the knee to the edge of the table, and require an assistant to hold the thigh firmly down; now place the left hand in the popliteal space, so as to depress the thigh, and the right on the

[1] R. Barwell. [2] T. Billroth.

posterior part of the leg close above the calf and on the condyles of the tibia; if the anchylosis is recent, and not too firm, the leg will gradually give way with a soft crackling and tearing; should extension not be so readily made, place the hand lower on the leg, about the calf or close below it, and use much less force to avoid fracturing the tibia just below the condyles; if these efforts fail, seize the leg from the front and attempt gradual flexion, as adhesions sometimes rupture more readily by flexion than extension; continue alternate flexion and extension until the limb is brought into proper position, but avoid painful twisting and wrenching.[1] If the patella is attached, it must first be loosened by pressure with the thumbs, or aided by some covered hard lever.

One cause of failure in the treatment of fibrous anchylosis is that the surgeon becomes alarmed at the audible fractures that occur and contents himself with slight motion for the present operation, intending to complete the cure by subsequent operations, and thus, by making frequent attempts to increase these slight movements, he sets up a new inflammation in the parts involved, preventing any further interference, and frequently resulting in a more firm consolidation of the joint than before; whereas, by breaking up the adhesions thoroughly and completely at the time of operation, and then, by proper dressings of the parts and the prevention of inflammation, he may confidently expect that he will have a much more satisfactory result.[2]

The immediate dressings which most effectually prevent inflammation are applied as follows:[2] First strap the toes with strips of adhesive plaster if it be a small subject, or if an adult with long toes, pad the toes with cotton and bind with bandage, carrying the roller over the foot strongly and firmly; padding the malleoli and tendo-achillis with cotton the roller is carried snugly over them; two strips of adhesive plaster having been placed on either side of the leg for extension, the roller is passed over them, leaving their lower extremities exposed for the future attachment of weight and pulley, and is carried up as far as the top of the tibia; pad the popliteal space and firmly strap with strips of adhesive plaster, each one shingling over the other until the entire knee is covered; continue the roller over the knee smoothly and very firmly to the junction of the middle and lower third of the femur, when a piece of sponge an inch or two in length, and about the size of the thumb, is placed over the track of the femoral artery, and the roller carried on over this sponge for the purpose of making partial compression of this artery, so as to diminish its calibre and thus prevent the full supply of blood to the parts below; great caution is necessary in the application of this pressure upon the artery not to obstruct the circulation so as to produce gangrene; then secure the limb in an absolutely immovable position either by a wooden splint well padded placed behind the leg, gutta-

[1] T. Billroth. [2] L. A. Sayre.

percha, sole leather, plaster of Paris, iron bars on either side of it, or in any way that best prevents the slightest possible movement. Place the patient in bed, the lower extremity of which is raised ten or twelve inches higher than the head in order that the body may act as a counter-extending force, and apply the weight and pulley over the foot of the bed to the strips of adhesive plaster at the ankle-joint; place ice-bags around the knee, and use such constitutional treatment as may be required; at the end of six or seven days remove the dressings, take the sponge from over the femoral artery, cut the adhesive straps from over the knee, carefully examine the parts, and give a very slight movement to the joint for the purpose of preventing solidification; reapply the dressings with the sponge left off from over the femoral artery; still continue the extension and the elevated position of the limb for some days, until all danger of inflammation is passed; at the end of a few days again remove the dressings, and give more free motion to the part. It may be necessary at the time of making this movement, and the three or four subsequent movements, to administer an anæsthetic; these movements should be made quite free when an anæsthetic is used, but not to the point of exciting any new inflammation. After some days the passive movements can be made daily, accompanied with friction, and shampooing should be very liberally done. These movements may be increased in frequency as the case advances, until finally an instrument can be so adjusted to the limb that the patient can cause the movements many times in the day without the attendance of his physician. So soon as the parts can be pressed together by bearing the weight of the body upon the foot without tenderness, the extension can be omitted, and the movements daily increased.

The proper support of the foot is an important indication in making extension. If the foot is not well sustained, so as to be freely movable, the weight has to be much increased, but if the limb moves with no friction, the weight may be comparatively light. To effect this object a simple framework is constructed which allows a cross piece to slide freely on two horizontal bars (Fig. 700).

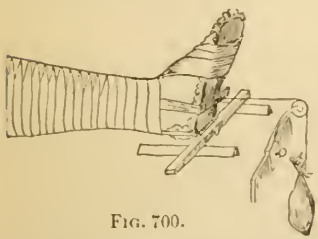


Fig. 700.

If the joint has long been bent at a right angle, not only do the structures about the joint contract, but the condyles lengthen so as to render it impossible to bring the tibia down to its proper position, even by dividing the resisting tissues, as the ham string tendons; in such cases the extremities of the condyles have been cut away successfully with antiseptic precau-

tions.[1] When flexion of the leg and subluxation of the tibia is progressing, the limb may be restored by gradual extension of the joint, and counter pressure over the upper extremity of the tibia (Fig. 701).[2]

The instrument consists of the steel bars A and B, connected by double joints with the intermediate piece C; each bar has on its end a roller for the webbing strap of the adhesive plaster, and the lower bar, B, has an extension bar to be regulated with a key, P; the leg rests in the wide padded bands, D and E, which are fastened to the bars by a single rivet only, on each side, so as to be movable and fit exactly in every position; the two straps, F F, pass across the lower part of the thigh, buckling on each side; a third band, G, is securely fastened on the upper end of the bar, B; connected with this band is an extension rod, H, which passes through the band, K; extension made with this rod throws the head of the tibia forward and downward; the band K can be put in different positions by the arrangement L; finally, there is the extension rod M, between the fixed bands, N and O.

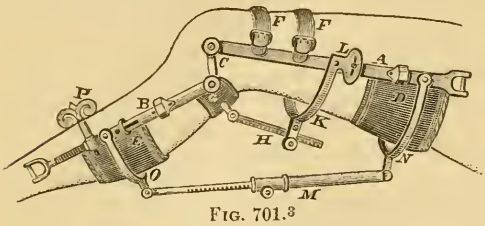


FIG. 701.[3]

If true anchylosis exist and the limb is in such a position as to be useful, no operation should be attempted. When, however, the flexion is extreme, the following procedures are justifiable, namely, amputation below the knee, exsection of the joint, or resection of the shaft of the femur.

(1.) If the limb is in a state of atrophy, amputation should be performed an inch below the tubercle of the tibia with bilateral flaps; this stump allows the application of an excellent artificial limb, with direct bearing upon the knee.[4] (2) If the leg is well developed a wedge-shaped piece of bone should be removed from the knee, of such shape and dimensions as to permit the foot to be brought to the ground at a slight angle, and in this position anchylosis should be obtained.[5] The operation is as follows: If the knee is at right angles, preparatory to the operation, divide the tendons of the biceps, semi-tendinosus, semi-membranosus, and gracilis muscles several days before. The tourniquet having been applied to the upper part of the thigh, or elastic bandage, make an incision from the outer to the inner condyle, across the middle of the patella, and a second incision from the middle of this, perpendicularly downwards, to the tuberosity of the tibia; dissect the included angles of integument down to a finger's breadth below and parallel with the margin of the articular surface of the tibia; cut the ligamentum patellæ and the fibro-ligamentous tissues on either side on the same level to the extent of nearly two thirds of the circumference of the bone. With the amputating saw make a section of the tibia at three

[1] J. Lister. [2] N. M. Shaffer. [3] G. Tiemann & Co. [4] E. D. Hudson. [5] G. Buck.

fourths of an inch below the joint anteriorly, directed with a slight obliquity upwards, so as to terminate at the margin of the articular surface posteriorly, *c*, *d* (Fig. 151); commence the second section through the upper part of the patella, parallel with the first, *a*, *b*, and on a plane forming an angle with it, less than a right angle, and continue to about the same extent as in the first section with the same saw; complete the remainder of the section through the tibia, as well as through the condyles, with a metacarpal saw and chisels; remove the included wedge-shaped portion of bone. The after treatment is the same as for excision of the knee-joint. (3.) A section of the femur may be made thus:[1] Remove a triangular portion of the shaft, *e*, *g*, *f* (Fig. 151); there should not be a complete section of the bone at its posterior part, *g*.

6. **The hip-joint** is liable to be anchylosed in various positions which incapacitate it. In the diagnosis of these deformities it is important first to determine the relation of the head of the femur to the acetabulum.

The following tests must be made: (1) Place one end of a tape measure on the tip of the anterior superior spinous process, stretch the tape over the diseased hip to the most prominent part of the tuberosity of the ischium, and if the trochanter major has its normal relation to the acetabulum, the tape will touch the upper border of the trochanter major in every position of the limb.[2] (2.) The ilio-femoral triangle 1, 2, 3 (Fig. 702)[3] in the normal condition of parts is a right-angled triangle, and is obtained thus: draw a line from the anterior superior spinous process to the top of the trochanter major, 1, 2, draw a second line from the anterior superior spinous process directly downwards to the horizontal plane of the recumbent body, 1, 3; draw a third line, 3, 2, the base of the triangle, at right angles to 1, 3; the base line, 3, 2, is the test line, being compared with the same line on the opposite side of the body.

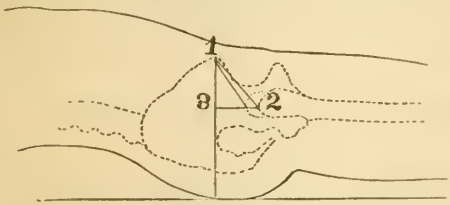


FIG. 702.

If the hip-joint is anchylosed in a flexed position while the disease is progressing in the head of the femur and acetabulum, the only effort at reduction should be by extension with the long hip splint, for rude movements of the bone are liable to aggravate the caries. If the disease has ceased, and the femur is fixed in an unnatural position by fibrous anchylosis, myotomy should be performed, and subsequently reduction should be attempted by force applied under an anæsthetic. If the anchylosis is osseous, and the distortion disabling, operative measures are justifiable.

1. Division of the neck, subcutaneously,[4] is made as follows: Recognize the top of the trochanter, and enter the knife (Fig. 703)

[1] J. R. Barton. [2] E. Nélaton. [3] T. Bryant. [4] W. Adams.

above it in the direction of the neck; open the capsule and fully expose the bone; then pass the saw (Fig. 704) along this incision, which must be maintained patulous, until the blade rests upon the neck; with a few passes the bone is divided at right angles to its axis; the saw is then withdrawn, the wound closed, and the limb brought into a proper position, and fixed on a splint. The antiseptic spray adds to the protection of the wound from the dangers of suppuration.

Fig. 703.

Fig. 704.

An ingenious instrument has been devised [1] which combines a subcutaneous saw, knife, and bone rasp (Fig. 705).

It consists of a trocar, fenestrated canula, 1 (Fig. 705), and a staff, 2, with handle and blunt extremity; a portion of this staff at a short distance from the extremity is flattened, one edge, B, being made into a knife-blade, and the other edge, C, being provided with saw-teeth; this staff, 2, is intended to replace the trocar in the canula after the latter is introduced; when in position, 3, either the saw, C, or the knife, B, edge of the shaft, according to the way the latter is turned, corresponds with the opening in the canula; the saw or

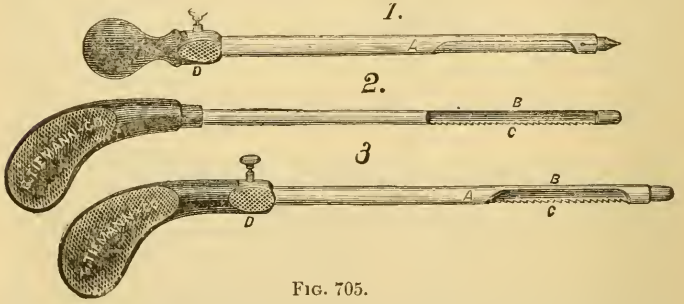


Fig. 705.

knife can then be worked to and fro within the canula by a piston-like movement, the canula being steadied by grasping the flange, D, at its base; if it be necessary to work the instrument as an ordinary blunt-pointed sheathed saw or knife, the shaft can be fixed in the canula and made into one piece by a thumb-screw in the handle. All that is necessary in using this saw is to thrust the trocar and canula into the limb, the fenestra of the canula being alongside of the bone upon which the operation is to be performed. The trocar is then withdrawn, the staff introduced in its place, 3, and worked as already described.

2. The superior epiphysis of the femur may be resected above the trochanter minor for true anchylosis; the operation has proved entirely successful both in regard to safety and the usefulness of the limb. The indication for resection at this point is the preservation of

[1] G. F. Shrady.

the insertion of the psoas magnus and iliacus internus muscles, attached to the lower fragment, for the purpose of flexion; the section of bone is designed to remove a semicircular piece thus, ⌒ with its concavity downward, and by rounding off the upper end of the lower section, to imitate the natural joint.[1]

7. **The lower jaw** may be anchylosed by cicatrices on one or on both sides. If its movements are too much restricted, an effort should be made to open the mouth by means of an instrument which describes the same curve in opening the blades as the jaw itself, and makes pressure upon the teeth directly upwards and downwards.[2] The blades should be covered with lead, or gutta percha, to protect the teeth, and the distending force may be a screw working vertically at the external ends of the blades,[3] or by a wedge propelled by a screw[4] (Fig. 706). In applying these forces the process of dilatation should be very slow, the instrument being repeatedly removed and reinserted as far as possible, in order to secure the support of as many teeth as are exposed. If the anchylosis is limited to one side and is unyielding, section of the bone should be made at the anterior margin of the cicatrix, which will enable the patient to use the free portion of the jaw. This section may be a simple division of the bone;[5] or to more effectually prevent reunion, a wedge-shaped piece may be removed,[6] three quarters of an inch wide above and an inch below.

Fig. 706.

CHAPTER LX.

COMPENSATIVE APPLIANCES.

Operative surgery may not only fail to correct deformities, but in its effort to save life may sacrifice useful parts, and leave the patient with maimed or defective limbs. The application of apparatus to compensate the loss of parts may be regarded as the fulfillment of the final obligation of the surgeon to the patient. Too often this most important duty is either imperfectly performed or entirely neglected. But in the present advanced state of mechanic art the surgeon is culpable who does not exhaust its resources in the effort to restore both the function and the symmetry of lost parts. It is the duty of every surgeon, therefore, to have that knowledge of compensative appliances which will enable him to prepare the maimed limb for the best possible apparatus, and to guide the patient to a judicious selection.

Compensative appliances[7] should be based upon the philosophical and scientific indications of each case, anatomically and physiologically considered. The supplemental apparatus, intelligently and artistically constructed and adapted, should restore lost or crippled parts to their normal condition and usefulness as nearly as possible. It is most important to bring mechanical surgery within the circle of professional interest and pursuits; for an improved amputation

[1] L. A. Sayre. [2] J. L. Little. [3] Rozer. [4] D. W. Goodwillie.
[5] Rizzoli. [6] F. Esmarch. [7] E. D. Hudson.

is of no value to the patient if it is abandoned to the non-professional, ignorant, and unappreciative for its ultimate treatment. Apparatus for palliative, remedial, or compensative purposes, as for diseased joints, lesions of nerves, deformities, ununited fractures, resections and amputations, can be safely and consistently intrusted to well educated and experienced physicians and surgeons, who are qualified to analyze the character of the case, and to perceive and define what is essential in apparatus to fulfill specific indications. This requirement becomes imperative when apparatus is intended to supply, or reinforce, physiological functions of limbs and parts rendered temporarily helpless or useless from nerve lesions, extensive injury, and deformity. The numerous and multiplying cases of resections of the superior and inferior extremities, as alternatives for amputations, furnish occasion for the interposition of professional knowledge and dexterity to sustain and justify those operations by the use of legitimate apparatus.

The following principle should always govern in the selection of prothetic apparatus, namely; in construction, the mechanism should so conform to the anatomy of the lost part that all of the normal functions will be as exactly reproduced as possible.[1]

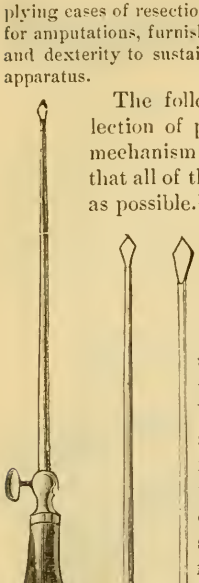


FIG. 707.[6]

I. PSEUDARTHROSIS.

The failure of ossific union of the ends of the bones after fracture may result in (1) union by fibrous tissue; (2) extreme mobility without union; (3) a rounded and pointed condition of the fragments which are connected by fibrous bands; (4.) A dense capsule containing fluid and the ends of the bones round and smooth, false joints.[2] The causes of non-union are numerous, and should be thoroughly studied in each case. It may be due to a want of proper apposition, or syphilis, or drunkenness, or general feebleness. In the treatment, the existing cause must, if possible, first be removed. The subsequent measures usually adopted generally have the following order: —

1. **Friction** of the fragments is produced by rubbing them together briskly, and then the parts are kept for a time in a state of rest: or the patient is allowed to move the limb slightly.

2. **The drill** is most useful in oblique fracture.[3] The common drill (Fig. 707)[4] may be employed, which works slowly owing to its half-rotation. A much more perfect drill has been devised,[5] which rapidly rotates on its axis by the mere opening and closing of the hand. Operate as follows: Make a slight puncture to the bone with a sharp-pointed bistoury; introduce the drill, in such direction as to enable it to be carried through the ends of

[1] E. D. Hudson. [2] G. W. Norris. [3] W. Detmold. [4] D. Brainard.
[5] G. F. Shrady. [6] G. Tiemann & Co.

the fragments, to wound their surfaces, and to transfix whatever tissue may be placed between them, withdraw it from the bone, but not from the skin, change its direction and perforate again; repeat this operation three or four times; place the limb in a condition of perfect rest, with a well applied gypsum bandage, and maintain this dressing for three weeks.

3. **Subcutaneous section** of the ligamentous structures may be safely made with a narrow bladed knife; an effort should be made to separate these tissues from the ends of the bone. The gypsum dressing must be applied.

4. **Resection and suture** of the extremities of the bones is followed by immediate results, but the operation has all the features of a compound fracture, and should not be practiced in the thigh. Make an incision down upon the bone, dissect out the two fragments, excise them, perforate close to the end, pass a firm silver wire and twist the ends together;[1] the antiseptic dressings must be used, as they render this operation free from dangerous suppuration.[2]

In cases which resist all these measures, or which are not adapted for such treatment, the last resource is the application of suitable apparatus which will enable the patient to use the limb. It often happens that under such treatment the patient regains vigorous health and the bones become firmly consolidated. It is a question yet to be determined whether these appliances ought not to be far more generally employed in place of the preceding operations.

In the application of such apparatus, remember, (1) that the pressure at the seat of fracture is as great as can be borne without inflaming the skin; (2) that in the lower extremities, the weight of the body is sustained by the upper part of the hollow splint, just as a stump is sustained in an artificial limb after amputation; the upper strap should, therefore, be firmly drawn when the patient is about to walk; but slackened when in bed or sitting up in a chair; (3) when worn for several months the inside lining and stuffing should be renewed, so as to give accurate support; (4) When, from union occurring, it is proposed to lay aside the splint, let it be taken off at night for ten days, or whilst sitting up in a chair, before any attempt is made to walk without it.[3]

1. **The ulna and radius** occasionally fail to repair after fracture, when an apparatus like the following may be usefully employed (Fig. 708).[3]

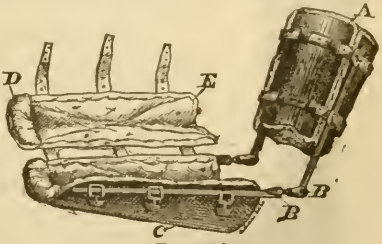


FIG. 708.

It consists of, A, piece accurately embracing the arm; B, joint for flexion and extension of forearm at elbow; B, pivot-joint permitting rotation of head of radius in semi-pronation and supination; C, ensheathing piece for forearm: D, a thick pad to press on styloid processes of ulna and radius at their carpal surfaces — so as to preserve the parallelism of these bones.

[1] T. Billroth. [2] J. Lister. [3] H. H. Smith.

2. **The humerus** is more often the locality of non-union than any other bone. An apparatus for its relief should fit closely to the rotundity of the shoulder, and should also embrace the forearm (Fig. 709), being accurately jointed at the elbow.

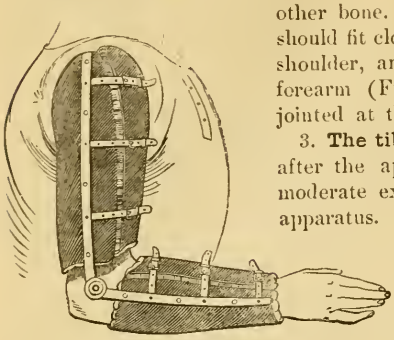


Fig. 709.

3. **The tibia** rarely remains ununited after the application of the drill and moderate exercise with an immovable apparatus. If non-union continue, apply a more durable apparatus.

This should consist of the following parts (Fig. 710):[1] A, support at middle of thigh; B, knee-joint in side-irons; C, main support of the body by accurate adjustment below the tubercle of the tibia; D, ankle-joint and boot. Or, the splint[2] may extend from beneath the head of the tibia to the malleolus, and continue from an ankle joint to a plantar plate, arranged one inch from beneath the foot, and allow the foot to be attached to it to overcome the shortening; strong leather bands and a graduated splint confine the limb and fragments of bones in position, while a padded leather band beneath and steel straps, with joints at the knee, extend from the leg-bonnet up the inner and outer aspects of the thigh, to attach to a thigh case; this affords efficient counter extension and support (Fig. 711).

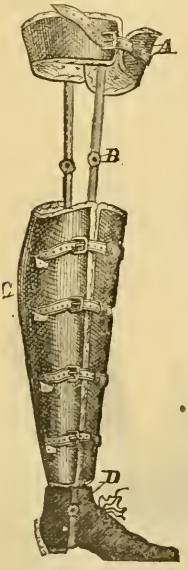


Fig. 710.

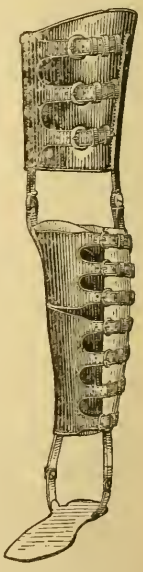


Fig. 711.

4. **The patella** rarely unites by bone, and there is great liability that by sudden flexion of the leg the fibrous adhesions will be ruptured. It is important that patients suffering from imperfect union should wear a support to the knee which not only sustains the parts firmly, but which will prevent flexion beyond a given degree.

If the patella is united by a very weak ligament, it is so impaired in function that the power of extending the leg upon the thigh is

[1] H. H. Smith. [2] E. D. Hudson.

greatly diminished, and sometimes nearly lost. This function may be preserved, when slightly impaired, by a simple apparatus, consisting of a leather knee-cap, strengthened posteriorly, and maintained in position by buckles. If the loss of power is very disabling, the apparatus should be more firm, and have a hinge-joint posteriorly, C (Fig. 713),[1] strong bands, A B, a ring acting over the anterior part of the joint D, with lateral bands F F. When the function is lost by separation of the fragments, the apparatus must completely compensate the loss of power of the quadriceps extensor (Fig. 719) by a spring at the joint.

Fig. 712.

A very useful apparatus (Fig. 712) consists of a cap of buckskin or satin jean, adjustable to the knee by buckles or laces, and provided with a pair of coaptation pads, to retain the newly united patella in place; these pads are arranged to approximate by drawing on laces of the cap; it affords the patient exercise of the knee-joint, the best guard against the danger of anchylosis, at the same time preventing any undue strain on the newly united upper fragment of the patella.

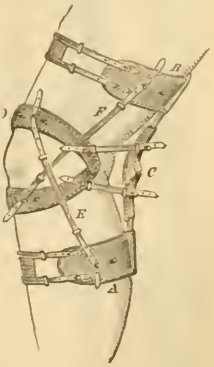


Fig. 713.

5. **The femur**, next to the humerus, most frequently fails of union. The disabling effect of this result is of the most serious character. Of the various operative methods of attempting to secure union all should be discarded in favor of the splint, which enables the patient to resume active exercise.[2]

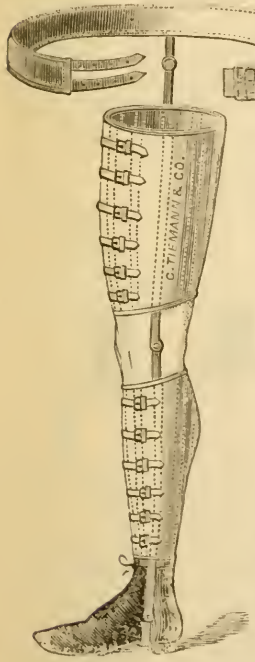


Fig. 714.

The apparatus should consist (Fig. 714) of a shoe, to which are attached two steel braces with ankle and knee joints, and a hip-band attached by a joint; the leg and thigh are firmly supported by leather splints with stout buckles.

[1] F. Bacon.

[2] E. D. Hudson.

II. PARALYSIS.

The various forms of paralysis affecting the extremities may be relieved by apparatus.

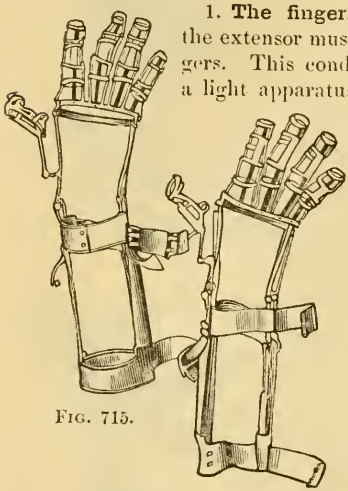


Fig. 715.

1. **The fingers** occasionally suffer paralysis of the extensor muscles, giving only flexion of the fingers. This condition may be greatly relieved by a light apparatus (Fig. 715), which constantly extends the fingers and wrist.[1]

2. **The wrist** may fall into the position of flexion, wrist-drop, from paralysis of the extensors of the carpus. This mal-position is readily rectified by a simple instrument, which makes elastic pressure on the thenar and hypothenar eminences (Fig. 716).

3. **The forearm and arm** affected by paralysis require the appliances recommended for ununited fracture.

4. **The ankle** is often weak from paralysis of the muscles attached to the bones of the foot. The joint is easily strengthened by apparatus with lateral steel braces fastened to the shoe (Fig. 717).

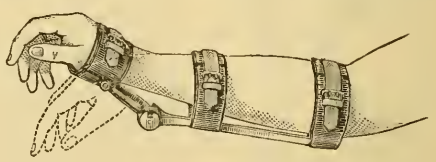


Fig. 716.

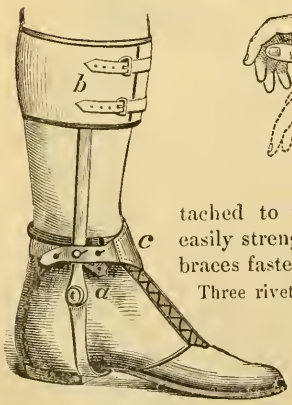


Fig. 717.

Three rivets are attached to the sole of a common laced shoe, a lateral stem is jointed at the ankle, *a*, passing as high as the centre of the calf, and here fixed to a band, *b*. The ankle is supported and kept in its corrected posture by a triangular V-shaped leather strap, *c*, acting against and buttoned to the steel stem on the opposite side. The best direction for selecting the side on which the instrument should be applied, is, that if the outer ankle has a tendency to eversion, the apparatus should invariably

[1] E. D. Hudson.

be placed to the inner side, and *vice versa*. In obstinate cases it is made with double stems, in order to give greater security, and to keep the sole in a strictly horizontal plane: the ankle may be further protected by a small, round, soft pad, to prevent chafing against the steel.

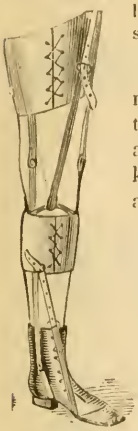


Fig. 718.

5. **The leg** may suffer from paralysis of some of its muscles so as to be too feeble to sustain the weight of the body. The best apparatus has, with a shoe, leg and thigh belt, lateral steel braces, with ankle and knee joints, and elastic bands supporting the ankle and knee (Fig. 718).

6. **The thigh** may suffer from paralysis of various muscles, but the most important is the quadriceps femoris; inability to extend the leg upon the thigh results from its paralysis or rupture, and the patient is no longer able to walk. This condition is relieved by an apparatus (Fig. 719). The instrument consists of steel supports, and strong elastics attached to cords, working upon eccentric leverages; the knee is entirely free from all pressure, and after the leg is bent by the flexors, extension of the leg upon the thigh promptly occurs.

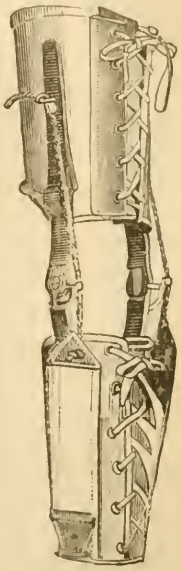


Fig. 719.

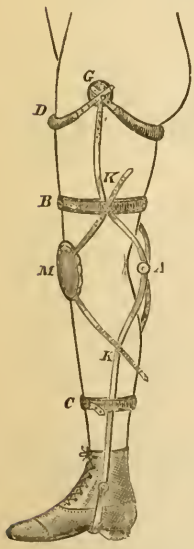


Fig. 720.

In cases of infantile paralysis, with atrophy and shortening of the limb, it is very difficult to supplement the loss by any ordinary means. The limb not only has to be strengthened, but also to be lengthened, in order to restore its function. This may be effected by the following apparatus (Fig. 720), namely, two upright steel bars, K, attached to the shoes, pass up either side of the leg nearly to the knee; they are then curved backward to the middle of the popliteal space, where they unite in a stop joint, A, which allows partial bending of the knee; from this point two lateral steel bars, K, diverge and pass upon either side of the thigh, the external as high as the trochanter major, G, and the inter-

nal, nearly to the groin; to the upper ends of these bars two bands are attached, the posterior being thickly padded and resting under the tuber ischii, and the anterior, D, of lighter material; a knee-cap, M, maintains the leg in position by means of lateral straps; two light bands pass around the leg, C, and the thigh, B; the shoe has an inside elevated sole to which the foot is attached, and which permits support on the foot in the act of walking. The effect of the apparatus is to render the defective limb of the same length as the well limb; the spine being thereby straightened, and the steps made equal; the body is carried on the posterior band. This apparatus is adapted to cases of hip-joint disease in the stage of recovery, for slight traction may constantly be made.

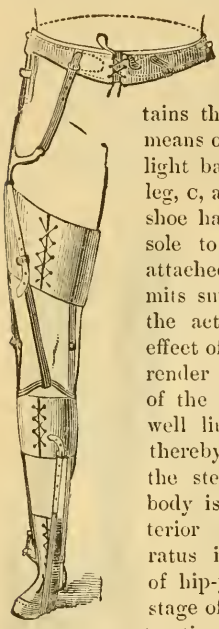


FIG 721.

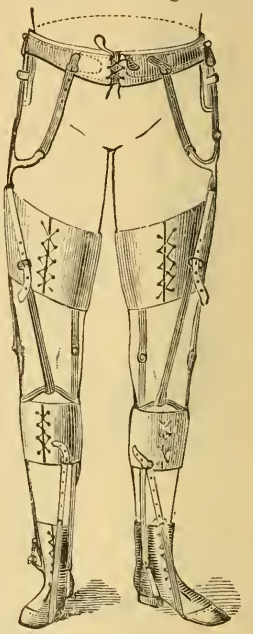


FIG. 722.

7. **The thigh and leg** affected by paralysis of the muscles require the same apparatus as the preceding, but it should be extended so as to embrace the hip by a belt (Fig. 721) to which the elastic straps are attached.

8. **Both lower limbs** may be paralyzed, and yet the patient may be enabled to resume the upright position, and walk about. The apparatus is simply the latter instrument made double (Fig. 722).

III. DANGLE LIMBS.

The flail-like movement of the upper extremities, after resection of bones and exsection of joints, frequently renders them entirely useless without apparatus, but with this, suitably constructed and adjusted, these limbs become very serviceable. The apparatus should consist of arm and forearm pieces, with a hinge-joint at the elbow (Fig. 723); the whole apparatus being maintained in connection with the trunk by shoulder-straps.

IV. ARTIFICIAL LIMBS.

The application of artificial limbs to supplement the losses occasioned by amputation must be regarded as the highest expression of mechanical art. The perfection of the mechanism of these appliances, when produced by skilled labor, is not excelled in any branch of human invention. Hands and arms, feet and legs, may now be obtained which are scarcely less useful, and are often even more ornamental, than the original limbs. And these appliances are now within the reach of the most humble person. The surgeon can no longer ignore these facts and discriminate between the rich and poor man's stumps; nor can the selection of these appliances longer be left to the patient himself, who is liable to be imposed upon by mere manufacturers, having no adequate knowledge of the proper functions of the apparatus which they are required to supply. It not unfrequently happens that the surgeon does not so fully understand the mechanism of these appliances as to be qualified to advise in their selection. Such ignorance implies also a want of good judgment in the formation of the stump to which the appliance is to be adjusted, and has received judicial condemnation. The important principle to be constantly borne in mind, in adapting stumps to artificial limbs, is the necessity of adequate leverage, and a well-composed and compact covering.[1]

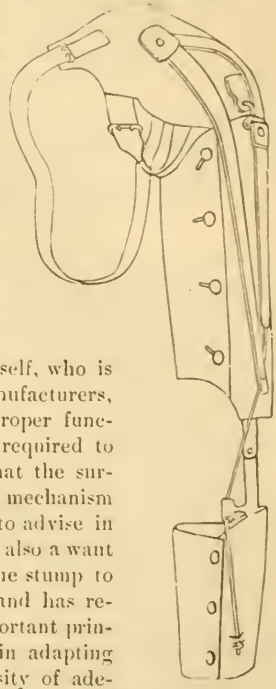


FIG. 723.

1. **The fingers**, individually or as a group, may be supplied with apparatus which admits of seizing and grasping. The fingers should be so placed and moved as to enable the normal thumb to oppose each one at all of its articulations, and when the fingers are closed the thumb should be in position to close over the first and second. If the thumb alone is lost, the substitute should be adapted to oppose the fingers (Fig. 724). If the thumb and forefinger are supplied, they must be in a state of

FIG. 724.

FIG. 725.

[1] E. D. Hudson.

opposition for the purpose of grasping, but the latter must be susceptible of easy extension (Fig. 725).

2. **The hand and forearm** are best supplemented when the stump is made above the wrist-joint and through the lower portion of the shaft of the ulna and radius;[1] the bulbous extremity of the radius, when the stump is at the wrist joint, is not adapted to the form of socket of the artificial limb. The position of the fore and second fingers and thumb, should be as far as possible that of opposition when closed. Pronation and supination are secured in the forearm, and the flexion and extension of the carpus are affected by cords acting through springs (Fig. 726). The cords may be acted upon by the movements of the opposite shoulder (Fig. 727).

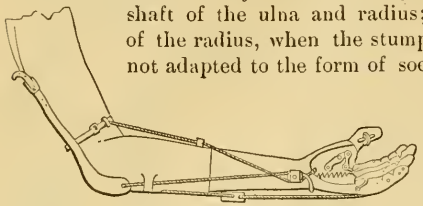


Fig. 726.

The spiral spring, *i* (Fig. 727), draws the fingers, *f*, constantly towards the thumb, *d*, and retains any article placed within the hand and between the thumb and fingers; the hand may be opened by a motion of the opposite shoulder drawing on the shoulder strap, *m*, and cord, *k*, or by extending the artificial hand and arm; the fingers are constructed on the metallic bar, *g*.

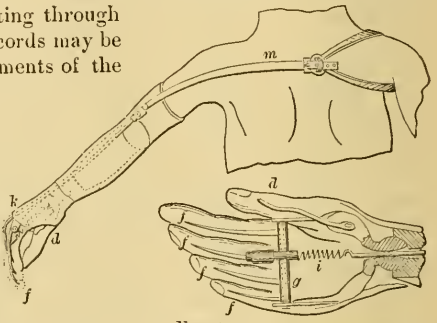


Fig. 727.

3. **The arm and fore-arm**, with the hand, are supplied, in amputations in the arm, by apparatus which derives its motion from the stump; the backward motion extends, and the forward motion flexes the joints of the arm and forearm.

In these cases the upper arm consists of a socket to receive the stump of the limb, and is secured by straps to the person with a certain degree of rigidity; the anterior and posterior tendons or rods have a firm attachment at or near the shoulder, pass along or through the upper section, and are attached to such points on the forearm that, as one or the other is tightened, the forearm is flexed or extended; in some cases the oscillation of the elbow-articulation is obtained by cords which have direct or intermediate attachment to the forearm, in others the cords or bars move a toothed wheel which engages a pinion on the elbow axis and gives motion to the forearm; the backward motion of the stump tends to strain the anterior tendon, which is so connected to the forearm behind the elbow-joint as to extend the forearm; the forward motion of the stump strains the posterior tendon which connects to the forearm in front of the articulation,

and thus flexes it as the stump is moved forward. These motions follow the natural ones, as, for instance, in the act of raising the hand to the mouth it is usual to oscillate the arm forward on the shoulder as a pivot, and backwardly as the hand descends; in the natural arm the pivotal position of the forearm is varied so as to cause the arm to swing in an arc which will bring the hand to the required place, as the mouth; in the artificial arm, the motion on the shoulder is the generator of the motion on the elbow, and a certain amount of prac-

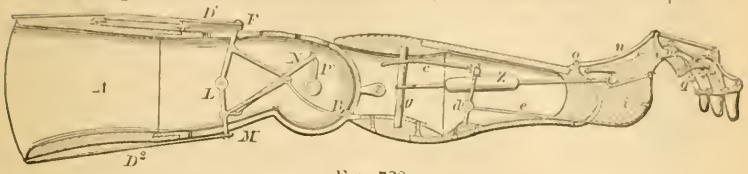


Fig. 728.

tice and adjustment is required to proportion the parts so that the consentaneous action of the parts which produce the compound motion may, without apparent constraint or indecision, land the hand at the object. When the trunk of a person affords points of attachment for the flexor and extensor straps, the motions of the shoulder itself, relatively to the thorax, and involving the clavicle and scapula, may be made to assist in executing the motions required. The primary motion of the stump having been communicated to the forearm by the means described (or other special devices which are various and very ingenious), the motions of the hand are derived from that of the forearm by means of tendons, slides, or other attachments (Fig. 728).

4. **The toes** may be supplemented by artificial means, but, in general, a boot provided with a heavy sole answers every purpose in progression. The same is true of amputation of the metacarpus.

5. **The foot** cannot be adequately substituted when the amputation is below the ankle-joint.

The tarso metatarsal and medio-tarsal [1] amputations will not hereafter be performed where there exist intelligent and humane regard for improved surgery, and the greatest benefit of the sufferer; the operations are in no respect conservative nor creditable to the surgeon who makes them.[2]

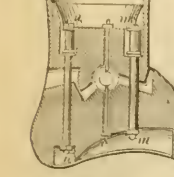


Fig. 729.

The ankle-joint stump affords space, firmness, and leverage for the artificial foot, and should be preferred whenever any considerable portion of the foot must suffer amputation, and whenever any of the soft tissues of the heel, or beneath the malleolus, or of the dorsum of the foot are sufficient to constitute either a single or double flap, even if necessary to form the cicatrix over the conical part of the base of the stump.[2] The appliance should have only flexion and extension at the ankle-joint (Fig. 729), and flexion of the toes.

[1] Chopart. [2] E. D. Hudson.

6. **The leg-stump** may be formed at any part, but the apparatus is the same in each case. The foot should be of the same mechanism as in the ankle-joint stump, namely, a socketed axial bolt passing transversely through it, giving only flexion and extension (Fig. 730). The construction of the leg-piece is designed to give lateral support by a well shaped and fitting socket; a thigh piece with joints in the steel side pieces is necessary to sustain the limb, and elastic straps are sometimes added which are attached to a yoke strap over the shoulder.

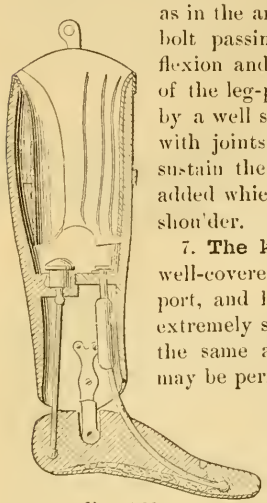


Fig. 730.

7. **The knee-joint amputation** leaves a broad, well-covered stump, which readily takes direct support, and hence, with a well-adjusted appliance, is extremely serviceable. The foot and leg pieces are the same as those already given. The knee-joint may be perfect in the motions of flexion and extension, and the padded socket should be exactly adapted to the form of the stump. The thigh should lace up in front, and straps may be added to sustain the whole upon the shoulder. The same apparatus is necessary when the amputation is at the point of election, for by flexion of the short stump the bearing is taken on the condyles of the femur in the same manner as in knee-joint amputation.

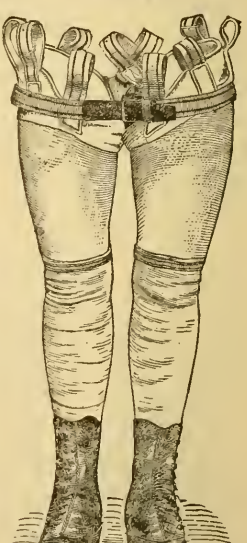


Fig. 731.

8. **The thigh** amputation requires a socket extending to the hip, with bands attached which may be applied over the shoulder to support the apparatus. The construction of other parts is the same as in amputations at the knee. In cases of double amputation these appliances may be adapted to both legs, so that the individual will have good motion[1] (Fig. 731).

9. **The hip-joint** disarticulation, though the severest form of mu-

[1] E. D. Hudson.

tilation, admits of the application of a most useful limb, through the medium of a gutta percha bonnet conformed to the entire ileo-lumbar parts.

CURVATURES AT THE KNEE.

The knee-joints occasionally become so weak through relaxation of the ligaments as to require compensative appliances to enable the patient to walk with any freedom. The relaxations are due to slight anomalies of formation, or too feeble development of those parts, and the results are manifested especially at the time when the growth is most vigorous, and the ends of the bones assume the final form.[1] Rickets is the most frequent cause of bending of the bones of the leg, and relaxation of the ligaments of the knee-joint. The curvatures are of two kinds.

1. **Genu varum**, bow-legs, depends upon relaxation of the external lateral ligament of the knee and shrinkage of the internal lateral ligament, except when it is due to bending inwards of the femur.[1]

2. **Genu valgum**, knock-knee, results generally from relaxation of the internal lateral ligament, and shrinkage of the external ligament, with secondary contractions of the biceps femoris.[1] In some cases, especially those induced by rickets, there is not only lengthening of the internal and shrinkage of the external lateral ligaments, but there is overgrowth of the internal condyle to such extent as to prevent straightening the limb.

In the early stages the weight of the body should be taken from the knee, either by confinement with a side splint to which the knee is firmly bandaged, or by allowing exercise with the common hip splint (Fig. 25) properly applied. In later stages apparatus is useful which straightens the limb, and supports it by means of a steel brace applied upon the concave side, with bands around the leg and thigh, and a cap for the knee. If both knees are affected, an apparatus must be applied to both limbs from the hips to the feet, not unlike that required in paralysis of both limbs (Fig. 722). If the external ligament is very tense and unyielding, and the internal condyle is not lengthened, it may be found impossible to straighten the limb without first rupturing or dividing these tissues.

The effort to forcibly straighten the limb is often so great as to fracture the femur in addition to rupturing parts,[2] and though the results have been favorable, previous tenotomy is the preferable method.[3]

If the deformity is due to curvature of the femur or tibia, these bones should be straightened by refracture with the chisel and mallet, and united in the straight position. In those cases in which the internal condyle has become lengthened, which will be apparent on inspection and manipulation, the deformity can be overcome only by

[1] T. Billroth. [2] Delore. [3] H. A. Reeves.

operative procedures. Section of the internal condyle must be made (Fig. 732) with a view to its replacement and reunion on a higher level (Fig. 733). This method is to be preferred to that of opening the joint and removing the redundant articular surface which has been safely practiced antiseptically.[1] The same objection may be made to section of the condyle with the saw, though the operation has been very successful, antiseptic precautions being used.

FIG. 732.

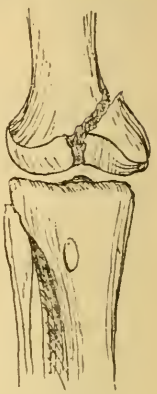


FIG. 733.

This operation[2] on the adult is as follows: Flex the knee as far as possible, and turn the thigh outwards; introduce a long and strong tenotome knife, three-and-a-half inches above the tip of the internal condyle on the inner side of the thigh, and so far back as to be opposite the ridge of bone running between the linea aspera and the condyle; carry the blade forwards, downwards, and outwards over the front of the femur, with its cutting edge directed to the bone; when its point is felt under the skin, in the groove between the condyles where the patella would normally have been lying in the flexed position, divide the soft parts and periosteum by withdrawing the knife; through the cut thus made introduce a narrow saw,[3] and divide the condyle nearly to the popliteal space; now forcibly straighten the knee, and the remaining attachments of the condyle will be readily fractured.

The following operation is free from the objections which apply to those methods involving a more or less free opening of the knee-joint:[4] Introduce a scalpel covered with carbolized oil just above the most prominent part of the internal tuberosity, and divide the soft parts and periosteum: insert by the side of the knife a chisel, also dipped in carbolized oil, and with a few strokes of the mallet penetrate the condyle to its greatest depth, but only as far as the cartilage covering it; the direction of the chisel should be first towards the intercondylar groove, then partially withdrawn, and its direction altered forwards and backwards, until the condyle is loosened, but not separated. Place a pad of lint saturated with carbolized oil over the incision, and apply a long straight splint to the outside of the leg, with a bracket at the knee; at the end of two weeks apply an immovable apparatus, as gypsum, and retain it for three or four weeks in children, and six to eight in adults, when passive motion must be begun and persevered in until the functions of the joint are completely restored.

[1] T. Annandale; J. Lister. [2] A. Ogston. [3] W. Adams. [4] H. A. Reeves.

INDEX.

Abdomen, anatomy of, 431.
herniæ of, 436.
Abdominal aneurism, 256.
aorta, ligation of, 257.
herniæ, 436.
Abnormal anus, 401, 419.
Abscess of abdominal walls, 433.
of alveolar process, 358.
antrum, 469.
brain, 285.
breast, 585.
cæcum, 398.
kidney, 498.
liver, 426.
nasal fossæ, 464.
pharynx, 376.
salivary glands, 363.
spine, 166.
tongue, 370.
tonsil, 366.
vermiform appendix, 397.
Acne rosacea, 320.
Acromio-clavicular dislocation, 149.
Actual cautery, 25.
Acupuncturators, 329.
Acupuncture, application of, 329.
Acupressure, 23.
in aneurism, 225.
Adhesive plaster dressing, 46.
Æstiversion, 25.
Affections, nervous, after wounds, 70.
Age in prognosis, 7.
in operations, 7.
Air in the veins, 38.
Alimentation, rectal, 408.
Alveolar process, abscess of, 358.
dentigenous cysts of, 359.
Alveolar process, vascular growths of, 359.
Ammonia in collapse, 37.
in narcosis, 35.
Amputation, atomizer for, 593.
at elbow joint, 608, 609.
hip joint, 629–632.
knee joint, 626, 627.
shoulder joint, 611–613.
considerations regarding, 590.
instruments for, 592.
methods of, 594.
by bilateral flaps, 596.
double flaps, 596.
periosteal flaps, 597.
rectangular flap, 596.
single flap, 595.
circular, 594, 595.
division of bone, 597.
of arm, 610, 611.
fingers, 601, 602.
forearm, 607.
leg, 624–626.
metacarpal bones, 603.
penis, 588.
phalanges, 599, 600, 614.
thigh, 628.
thumb, 602.
tibia, 623.
toes, 614.
place of, 591.
preparations for, 591.
supra-malleolar, 624.
through metatarsal bones, 616.
time of, 590.
wound, care of, 598.
Amygdalotomy, 367.

Amyl nitrite in narcosis, 35.
Anæsthesia, 26.
general, 27.
local, 30.
Anæsthetics, 27.
chloroform, 29.
nitrous oxide, 27.
sulphuric ether, 27.
rapid respiration, 30.
Anchylosis, causes of, 640.
of elbow joint, 642.
hip-joint, 647.
knee-joint, 643.
phalangeal joints, 642.
shoulder joint, 643.
wrist joint, 642.
Aneurism, 221.
abdominal, 256.
arterio-venous, 219.
by anastomosis, 220.
symptoms, 221.
treatment, 221.
cirsoid, 220.
gluteal, 256.
ileo-femoral, 256.
popliteal, 257.
varicose, 219.
needles, 233–235.
use of, 234.
treatment, 222, 233.
by acupressure, 225.
compression, 224.
constriction, 225
elastic bandage, 223.
electrolysis, 223.
flexion, 223.
foreign bodies, 223.
injection, 222.
ligation, 223, 233.
manipulation, 222.
Aneurismal varix, 219.
Angioma, plexiform, 231.
Angiomata, cavernous, 230.
Ankle joint, excision of, 179.
braces for, 161.
caries of, 160.
disarticulation at, 621, 622.
dislocations of, 153.
compound, 153.
Ankle joint, weakness of, 654.
Antiseptic dressing, 44.
agents, 42.
method, 42, 58.
Anthrax, 315.
seat of, 316.
Antrum, anatomy of, 469.
abscess of, 469.
dropsy of, 469.
Anus, abnormal, 401, 419.
absence of, 418, 421.
anatomy, 416.
and rectum, 421.
artificial in intestinal wounds, 401.
contraction, 417.
exploration of, 417.
fistula in, 423.
tissue of the, 421.
vaginal fistula in, 419.
vesical fæcal fistula in, 420.
Aorta, abdominal, ligation of, 257.
aneurism of arch, 237.
Apparatus, compensative, 649.
for dangle limbs, 656.
femur, 653.
humerus, 652.
non-united fractures, 651–653.
paralysis, 654–656.
patella, 652.
tibia, 652.
ulna and radius, 651.
plastic, 53.
Applications, endermic, 328.
Apnœa, 35.
Arm, amputation of, 610, 611.
artificial, 658.
paralysis of, 654.
Arterial compression, 19.
by fingers, 20.
key, 20.
ligature, 21.
tourniquet, 20.
hæmorrhage, 215.
thrombosis, 220.
Arteries, anatomy of, 233.
acupressure, 23, 225.
compression of, 224.
contusion of, 214.
diseases of, 220.

Arteries, general operations on, 233.
ligation of, 223, 233.
rupture of, 214.
wounds of, 215, 216.
Arterio-venous aneurism, 219.
Arteriotomy, 233.
Artificial limbs, 656–659.
respiration, 35.
methods of, 36.
Ascites, tapping in, 435.
Aspiration of intestines, 393.
Aspirator, 501.
Astragalus, resection of, 133.
dislocation of, 153.
Atheroma, 221.
Atomizer, 473.
antiseptic, 593
Atrophy of nails, 322.
Axillary artery, aneurism, 246.
ligation of, 249.
methods, 250, 251.
relations, 249, 251.

Bandages, circular, 56.
double-headed, 52.
elastic, 18.
application, 18.
in aneurism, 223 .
figure of eight, 52.
gypsum, 54.
recurrent, 53.
roller, 50.
silica, 55.
spica, 52.
spiral, 51.
starch, 54.
T, 53.
dangers of, 50.
materials for, 50.
Battery, galvano-cautery, 369.
Bilateral lithotomy, 521.
Bisector, 522.
Bistoury, laryngeal, 480.
Bladder, anatomy of, 502.
aspiration of, 511.
calculi of the, 512, 513.
in women, 526.
exploration of, 503.
extroversion of, 505.
Bladder, foreign bodies in, 511.
inflammation of, 509, 510.
rupture of, 507.
wounds of, 508.
Bleeding, 37.
Blood-letting, 269, 272, 273.
local, 272, 273.
cupping, 273.
leeching, 272, 273.
scarification, 273.
rules, 269, 272.
Boils, cause and treatment, 315.
Bones, caries, 107.
diseases of, 101.
general operations on, 111.
inflammation of, 106.
injuries of, 8.
metacarpal, amputations of, 603.
disarticulations of, 603–606.
metatarsal, amputation at, 616.
disarticulation of, 616–618.
necrosis, 109.
rickets, 101,
tumors, 102.
Bougies, bulbous, 529, 537.
filiform, 537.
Brachial artery, anatomy, 251–253.
ligation of, 251.
methods, 251–253.
precautions, 252.
plexus, 297.
resection, 297, 298.
Brain, abscess of, 285.
bruising of, 276.
commotion of, 275.
compression of, 276.
concussion of, 275.
contusion of, 276.
hernia of, 277, 285.
inflammation of, 283.
wounds of, 277.
Breast, abscess of, 585.
extirpation of, 588.
inflammation of, 588.
scirrhus of, 587.
tumors of, 587.
Bristle probang, 377.
Bronchi, anatomy of, 490.
foreign bodies in, 490.

Bronchocele, varieties of, 489.
Burns, degrees of, 312.
cicatricial contractions in, 313.
Bursæ, deep, 198, 199.
inflammation of, 198.
deltoid, 198.
ligamentum patellæ, 199.
quadriceps extensor, 198.
superficial, 199.
wounds of, 198.

Cæcal abscess, 398.
Cæcum, abscess of, 398.
anatomy of, 396.
intussusception of, 399.
perforation of appendix, 397.
wounds of, 396.
Cæsarean section, 570.
Calculi of salivary glands, 363.
Calculus, renal, 499.
vesical, 512.
seat of, 513.
operations for removal of, 513.
of urethra, 534.
extraction of, 535.
Callosity, 313.
treatment, 314.
Cancer of the nose, 469.
of the tonsil, 367.
colon, 405.
penis, 557.
treatment, 558.
rectum, 415.
testicle, 551.
tongue, 372.
operations for removal, 372–374.
uterus, 571.
Carbolic acid dressing, 42.
Caries of bone, 107.
central, 108.
external, 109.
fungating, 156.
internal, 109.
of joints, 156.
ankle joint, 160.
carpal joints, 161.
hip joint, 158.
knee joint, 160.
Caries of tarsal joints, 161.
of vertebræ, 162.
simple, 156.
superficial, 107.
Carcinomata, 105.
Care, degree of, 3.
Carotid, common, aneurism of, 238.
direction of arteries, 239.
external, ligation of, 242.
wounds of, 216.
internal, ligation of, 242.
wounds of, 216.
ligation of, 239–241.
relations, 239, 240.
wounds of, 216.
Carpal joints, caries of, 161.
Case of instruments, 15.
Castration, 551.
Catch forceps, 22.
Catgut ligature, 22.
Catheter, Mercier's, 554.
sigmoid, 576.
Squires', 554.
velvet-eyed, 529.
Catheters, 503, 529.
introduction of, 504.
selection of, 503.
Catheterism, prostatic, 553, 554.
in the female, 544.
in the male, 504.
Cauterization, 25.
actual cautery, 25.
thermo-cautery, 26.
Cellulitis, causes, 316.
treatment, 317.
Chain saw, 114.
Chilblains, 311.
treatment, 312.
Chisel, 116.
Chloroform, 29.
administration, 29.
Cholecystotomy, 429.
Chondromata, 103.
Cicatrices, growths on, 339.
Cicatricial contractions, 337.
causes, 337.
operations for, 337–339.
selection of methods, 338.
Cicatrix, adherent, 78.

Cicatrix, contracted, 78.
defective, 77.
prevention, 78.
exuberant, 78.
forms of, 78.
painful, 79.
variations, 77.
Cicatrization, normal, 73.
Circular edge saw, 115.
Circulatory system, diseases of, 220.
aneurism, 221.
by anastomosis, 220.
cirsoid, 220.
atheroma, 221.
injuries of, 216.
thrombosis, arterial, 220.
venous, 225.
Cirsoid aneurism, 220.
Clamp, Bodenhamer's, 558.
nasal, 462.
Thomas, 564.
varicocele, 547.
Clavicle, fracture of, 82.
treatment, 83.
union in, 84.
relations of, 130.
resection of, 128.
methods, 129, 130.
shot fracture of, 97.
Claw forceps, 22.
Claw nails, 324.
Cleansing of wounds, 40.
Cleft palate, 351.
operations for, 352.
varieties of, 351.
Club-foot, 636–640.
appliances for, 637–639.
rules for treatment, 636, 637.
shoes, 637, 638.
Coccyx, resection of, 137.
Collapse, symptoms of, 38.
Collodion in wounds, 46.
Colon, anatomy of, 400, 403.
cancer of, 405.
section of, 403.
stricture of, 401.
wounds of, 400.
Colotomy, after-treatment, 405.
operation of, 403.
Compression, after fracture, 634.
arterial, 19.
by fingers, 20.
key, 20.
ligature, 21.
tourniquet, 20.
elastic, 18.
in aneurism, 224.
methods, 224, 225.
in incised wounds, 304.
of brain, 276.
of nerves, 282.
Compound fractures, 95.
anæsthetics in, 95.
antiseptics in, 95.
definition, 95.
indications, 95.
plastic dressing, 95, 96.
reduction, 95.
Conclusion of operation, 34.
Concussion of the lungs, 494.
of brain, 275.
symptoms, 275.
treatment, 275.
of the spine, 278.
hæmorrhage in, 279.
in railway injuries, 279.
symptoms, primary, 278.
secondary, 279.
treatment, 279.
Conformity to established rules, 3.
Consent to operation, 11.
Constitutional diseases in prognosis, 7.
Constitution, nervous, 291.
Constriction, 24.
advantages, 24.
application, 25.
in aneurism, 225.
Constrictor, 24.
Contraction of soft palate, 356.
of anus, 417.
treatment, 417.
cicatricial, 199, 200, 337.
Contusions, appearances, 303.
degrees of, 302.
of arteries, 214.
treatment, 214.
of brain, 276.
treatment, 276.

Contusions of nerves, seat of, 282.
symptoms, 282.
treatment, 282.
of scrotum, 545.
of veins, 217.
treatment, 218.
varieties, 217.
Convalescence, nurse, 15, 16.
room for, 16.
ward for, 16.
Cord, spermatic, hæmatocele of, 548.
hydrocele of, 548.
varicose veins of, 548.
Corn, treatment of, 314.
Cotton wool dressing, 44.
Cranium, trephining of, 291.
indications for, 291, 292.
inflammation within, 283.
Croupous granulations, 75.
Cuboid bone, resection of, 132.
Cuneiform bone, resection of, 132.
Cupping, instruments for, 273, 274.
Curved saws, 115.
Cutaneous horn, 314.
Cystic tumors of ovary, 561.
Cystitis, acute, 509.
chronic, 510.
irrigation in, 510.
Cysts, dentigerous, 360.
ovarian, 561.

Day for operations, 13.
Decision as to operation, 10.
Delirium tremens after operations, 71.
Delirium nervosum after operations, 71.
Dentigerous cysts, 359, 360.
Diagnosis, elements of correct, 5.
history of patient, 6.
progress of disease, 6.
Digital nerves, resection of, 299.
Dilator, Gouley's, 518.
Diligence, what constitutes, 3.
Director, 31.
Disarticulation: at ankle-joint, 621.
medio-tarsal, 619.
metacarpal, 603–606.
of metatarsal bones, 616–618.
tarsus, 620.
toes, 614, 615.
Disarticulation: radio-carpal, 606.
tarso-metatarsal, 618.
Diseased granulations, 74.
Dislocations, 148.
acromico-clavicular, 149.
compound, 148.
definition, 148.
general treatment, 148.
of ankle joint, 153.
elbow joint, 150.
hip joint, 151.
knee joint, 153.
patella, 153.
phalanges, 153.
shoulder joint, 149.
tarsal bones, 153.
vertebræ, 149.
wrist joint, 151.
signs of, 148.
sterno-clavicular, 149.
temporo-maxillary, 148.
Dissection, 31.
in ligation of arteries, 236.
Divulsion in strictures, 540, 541.
Divulsors, urethral, 540, 541.
Dog forceps, 21.
Dorsalis pedis artery, ligation of, 268.
penis artery, ligation of, 260.
Douches, nasal, 460.
Drainage of wounds, 41.
tubes, 167.
Drains, application of, 41.
materials for, 41.
Dressing, adhesive plaster, 46.
antiseptic, 41.
rules governing, 40.
principles of, 39.
bandages for, 50.
cotton wool, 44.
collodion, 46.
of wounds, 39.
by adhesive plaster, 46.
antiseptic method, 41, 58.
carbolic acid, 42.
cotton wool, 44.
collodion, 46.
interrupted suture, 46.
twisted suture, 47.
quilled suture, 47.

Dressing of wounds, preparation, 40.
principles, 39.
hot water, 49, 59.
ordinary, 45, 58.
plastic apparatus, 53.
Drill, in fracture, 650.
Duodenum, anatomy of, 388.
foreign bodies in, 388.
wounds of, 389.
gunshot of, 391.

Ecchymosis, 217.
Elastic bandage, 18.
application of, 18.
compression, 18.
rings, 19.
application of, 19.
Elbow, dislocation of, 150.
forms, 150.
reduction, 150, 151.
Elbow-joint, amputations at, 608, 609.
anchylosis of, 642.
excision of, 173.
after treatment, 176.
methods, 175.
mortality after, 174.
motions of, 173.
results of, 174.
subperiosteal, 175.
Electricity in collapse, 38.
Electric probe, 308.
Electrolysis, in aneurisms, 223.
Elements of correct diagnosis, 5.
Elephantiasis arabum, 319.
of scrotum, 546.
Elevators, 145.
Emergencies, 34.
air in the veins, 38.
bleeding, 37.
narcosis 34.
shock, 37.
Emphysema, 495.
Encephalocele, 287.
Endermic applications, 328.
Endoscope, 503, 528.
Enterotome, 392.
Enterorrhaphy, 390.
Epididymitis, 549.
Epigastric artery, ligation of, 261.
Epispadias, 532.
Epistaxis, 462.
Epithelioma of labia, 577.
of skin, 320.
Epulis, 358.
Erethitic granulations, 74.
Erysipelas, complicating wounds, 64.
Erysipelatous inflammation, 314.
Erythema, 63.
Established rules, conformity to, 3.
Ether, 27.
administration of, 27, 28.
apparatus to administer, 28.
Examination, 5.
physical, 6.
Excision of testicle in varicocele, 230.
of joints, 168.
indications, 168.
methods, 168.
of ankle joint, 179.
elbow joint, 173.
hip joint, 187.
knee joint, 182.
metacarpal joints, 169, 179.
metacarpo-tarsal joints, 179.
phalangeal joints, 169, 179.
shoulder joint, 176.
tarsal joints, 179.
wrist joint, 169.
time of, 168.
Exostoses, 103.
Exploration of anus, 417.
of rectum, 405.
methods of, 406.
of uterus, 566.
of vagina, 571.
Extension, after fracture, 634.
Extirpation of ovaries, 560.
of the tongue, 372-374.
of rectum, 415.
after-treatment, 416.
of prostate and bladder, 416.
larynx, 480.
methods of, 481, 482.
Extraction of teeth, 360.
bicuspids, 361.
cuspids, 361.
dentes sapientiæ, 361, 362.
incisors, 361.

Extraction of teeth, indications for, 360.
instruments for, 360, 361.
molars, 361, 362.
Extroversion of bladder, 505.
treatment, 506.
by operation, 506.
Exuberant granulations, 77.

Facial artery, ligation of, 243.
nerve, anatomy, 297.
section, 297.
Fasciæ, contractions of, 200, 201.
Fasciatomy, 202.
Femur, non-united fracture of, 653.
fracture of, 88.
direction, 88.
in children, 91.
point of, 88.
treatment of, 88–90.
resection of, 136.
methods of, 136, 137.
shot-fracture of, 99.
Femoral artery, anatomy, 262.
ligation of, 262.
methods, 262, 263.
wounds of, 217.
Fever, inflammatory, 66.
hectic, 69.
pyæmic, 69.
septic, 69.
traumatic, 66.
Fevers complicating wounds, 65.
classification, 66.
development, 66.
Fibromata, 105.
Fibrous tumors, soft, 320.
uterine, 568.
Fibula, resection of, 134.
Fingers, amputations of, 601, 602.
artificial, 657.
distortion of, 634, 642.
flexion of joints of, 634.
paralysis of, 654.
supernumerary, 633.
webbed, 633.
Fissure of anus, 421.
dilatation in, 423.
examination of, 422.
symptoms, 421.
Fissure of anus, treatment, 422, 423.
Fissures of skull, 277.
of base, 277.
symptoms of, 277,
treatment of, 277.
with scalp wound, 277.
Fistula in ano, 423.
examination for, 424.
operative methods, 424, 425.
blind, 422.
vaginal, 419.
vesical, fæcal, 420, 421.
vesico-vaginal, 574.
Fistulæ of salivary glands, 363.
Flexion in aneurism, 223.
Foot, artificial, 659.
Forceps, in amputation, 598.
bone, 114, 116.
bull-dog, 21.
catch, 22.
claw, 22.
curved serrated, 366.
needle, 575.
œsophageal, 378, 379.
pharyngeal, curved, 376.
serrated, 574.
suture 47.
tenaculum, 21, 866.
tongue, 357.
tonsil, 366.
with slide, 21.
wire twisting, 351.
Forearm, amputation of, 607.
artificial, 657.
paralysis of, 654.
Foreign bodies in aneurism, 223.
in bladder, 511.
removal of, 512.
in bronchi, 490.
duodenum, 389.
larynx, 475.
nose, 464.
œsophagus, 378.
pharynx, 376.
rectum, 414.
stomach, 387.
thoracic cavity, 492.
trachea, 484.
urethra, 534.

Fractures, 81.
compound, 95.
anæsthetics in, 95.
antiseptics in, 95.
definition of, 95.
indications in, 95.
plastic dressing in, 95, 96.
reduction of, 95.
diagnosis of, 81.
examination, 80.
gypsum splints, 81, 92, 93, 94.
of clavicle, 82.
femur, 88.
fibula, 93.
humerus, 84.
inferior maxilla, 81.
laryngeal cartilages, 474.
olecranon process, 87.
patella, 91.
radius, 85.
and ulna, 68.
ribs and cartilages, 82.
skull, 277, 278.
depressed, 278.
of base, 277.
the spine, 280.
lesion of cord in, 280.
prognosis in, 280, 281.
seat of, 280, 281.
tibia, 92.
and fibula, 93.
plastic apparatus, 81, 83, 88, 90, 92–94.
bandages, 81, 53, 90.
shot, 96.
simple, 80.
ununited, 650.
appliances for, 651–653.
Fibula, fracture of, 93.
Free torsion, 23.
Frost-bite, 311.
Fulcrum, 575.
Furuncles, 315.

Gall stones, 429.
cholecystotomy in, 429.
Galvano-cautery, 369.
Ganglia, 197, 198.
Gangrene during repair, 61.
Gangrene, hospital, 62.
phagedæna, 62.
traumatic, 61.
Gastrotomy, 388.
Gastrostomy, 482.
after-treatment, 384.
indications for, 382.
operative methods, 382, 384, 385.
Gastrorhaphy, 386.
General anæsthesia, 27.
Genu valgum and varum, 661.
Gland, thyroid, anatomy of, 488.
excision of, 489.
hypertrophy of, 488.
prostate, hypertrophy of, 552.
Glands, sebaceous, 321.
salivary, 362.
abscesses of, 363.
anatomy of, 362.
calculi of, 363.
fistulæ of, 363.
tumors of, 364.
wounds of, 362.
Glanders, 311.
Glossitis, 370.
Gluteal aneurism, 256.
artery, ligation of, 259.
Goitre, 488.
Gouges, 116.
Grafting, method of, 76.
Granulations, diseased, 74.
croupous, 75.
erethitic, 74.
exuberant, 77.
indolent, 75.
Growths, laryngeal, 478, 480.
of alveolar process, 359.
vascular, 359.
warty, 359.
horny of nails, 324.
Gunshot wounds, 305.
after-treatment, 310.
by cannon balls, 306.
irregular missiles, 307.
musket balls, 306, 307.
small projectiles, 306.
examination of, 307.
instruments for diagnosis, 308.
nature of, 306.

Gunshot wounds, removal of projectile, 308.
of lungs, 494, 495.
Gypsum jacket, 163, 165.
splint, 54, 81, 88, 92-94.
splint for hip, 192.
when applied, 81.
bandage, 83, 90.
ankle brace, 161.
knee brace, 160.
tarsal dressing, 162.

Habits in prognosis, 8.
Hæmatocele, of spermatic cord, 548.
of testicles, 549.
Hæmorrhage, 17.
during repair, secondary, 60.
intermediary, 60.
parenchymatous, 61.
in incised wounds, 303.
umbilical, 434.
from the lungs, 495.
acupressure in, 23.
aertiversion in, 25.
arterial compression in, 19.
cauterization in, 25.
constriction in, 24.
ligation in, 21.
torsion in, 22.
from nose, 462.
Hæmorrhoids, 227, 414.
clamp for, 558.
Hæmo-thorax, 496.
Hair follicles, retained secretions, 321.
overgrowth of, 320.
Hand, artificial, 656.
Hare-lip, double, 342.
single, 341.
operations for, 342.
rules for operating, 341.
varieties of, 340.
Heart, wounds of, 213.
extraction of foreign bodies, 214.
normal position of, 233.
operations on, 232, 233.
Hectic fever, 69.
Hemp ligature, 22.
Hernia, abdominal, 436.
contents of, 437.
Hernia, cerebri, 277, 285.
femoral, 450.
strangulated, 451.
inguinal, 442.
anatomy, 442.
direct, 449.
oblique, strangulated, 446.
operation for, 446.
radical cure of, 445.
trusses for, 443, 444.
varieties of, 443.
irreducible, 438.
operation for, 441.
reducible, diagnosis of, 437.
operation for, 438.
truss for, 438.
sac of, 436.
strangulated, 438.
umbilical, 452.
strangulated, 454.
treatment, 453, 454.
varieties of, 436.
pulmonary, 495.
Hip, splints for, 159.
dislocations of, 151.
reduction, 152.
varieties, 151.
Hip-joint, anatomy, 629.
amputation at the, 629.
by circular method, 683.
double flaps, 630.
single flaps, 630.
oval, 632.
anchylosis of, 647.
excision of, 187.
after-treatment, 191, 192.
indications, 188.
methods of, 189, 190.
mortality after, 187.
period of operation, 188.
results, 187.
caries of, 158.
splints for, 159.
History of patient, 6.
Hook, double for uvula, 357.
Horn, cutaneous, 314.
Horny growths of nails, 324.
Hospital gangrene, 61.
Hot-water treatment of wounds, 49.

Hour for operations, 13.
Humerus, fracture of, 84.
non-united fracture of, 652.
resection of, 124.
after-treatment, 124.
methods of, 124–126.
mortality after, 124.
shot fracture of, 97.
Hydrocephalus, 285.
acquired, 286.
compression in, 286.
congenital, 285.
tapping in, 285.
Hydrocele, 547, 548.
Hydrophobia, 311.
Hydronephrosis, 501.
aspiration in, 502.
Hymen, imperforate, 577.
Hypertrophy of the tongue, 370.
of tonsils, 366.
lips, 343, 344.
nails, 323.
spleen, 430.
alveolar process, 359.
Hypodermic injections, 331.
needles, 331, 332.
rules for, 332.
syringes for, 331.
solutions for, 332.
Hypospadias, 529.
operative methods, 530–532.
Hysterotome, 567.

Ileum, intussusception of, 392.
obstruction of, 395.
strangulation of, 394.
wounds of, 389, 390.
Iliac arteries, ligation of, 257, 258, 260.
common, 257.
anatomy of, 257.
external, 260.
internal, 258.
Ilio-femoral aneurism, 256.
Imperforation of rectum, 408.
Imperforate anus, 417.
treatment, 418.
nose, 461.
urethra, 529.
Incised wounds, 303.
Incised wounds, hæmorrhage in, 303.
ligation in, 304.
torsion in, 304.
tourniquet in, 303.
Incision, how made, 33, 34.
Incisions in ligation, 235, 236.
Indolent granulations, 75.
Inferior maxilla, resection of, 139.
fracture of, 81.
shot fracture of, 97.
Inferior dental nerve, resection of, 296.
Inflammations, acute, 65.
carbuncular, 315.
chronic, 65.
conditions favoring, 63.
forms of, 63–65.
erysipelas, 64.
erysipelatous, 314.
erythema, 63.
in repair of wounds, 63.
of bladder, 509.
bone, 106.
osteo-myelitis, 107.
periostitis, 106.
brain, 283.
breast, 585.
bursæ, 198, 199.
joints, 154.
parenchymatous, 154.
purulent, 154.
serous, 154.
meninges, 283.
muscles, 196.
nail, acute, 322.
chronic, 322.
nerves, 289.
tendons, 196.
phlegmonous, 316.
scrotal, 545.
septic, 64.
Inflammatory fever, 66.
Infra-orbital nerves, anatomy, 294.
section, intra-buccal, 294.
cutaneous, 295.
Ingrowing nail, 323.
Inguinal hernia, 442.
Inhalations, apparatus for, 473.
formulæ for, 473.
Inhaler, 473.

Injections, hypodermic, 331.
in aneurism, 222.
intravenous of milk, 271.
of brandy in collapse, 38.
of milk, 38.
rectal, 407, 408.
Injuries, of bladder, 507.
of bones, 80.
circulatory system, 213, 220.
joints, 147.
muscles, 193.
nervous system, 275.
penis, 555.
prostate gland, 552.
tegumentary system, 302.
thorax, 491.
urethra, 533.
Innominate artery, anatomy, 238.
aneurism of, 237.
ligation of, 238, 239.
relations of the, 238.
Instruments, 14.
case of, 15.
for resection, 113–116.
material of, 15.
preservation of, 15.
tests for, 15.
to operate on tongue, 368.
trephining, 145.
Insufflators, 460, 461.
laryngeal, 473.
Intermediary hæmorrhage, 60.
Internal pudic artery, anatomy, 259.
ligation of, 259.
methods, 259, 260.
cutaneous nerve, 298.
exposure of, 299.
resection, 299.
section, 299.
Intestines, gunshot wounds of, 89–391.
intussusception, 392, 399.
obstruction, 395.
strangulation, 394.
large, wounds of, 400.
Intussusception, cæcal, 399.
of jejunum and ileum, 392.
aspiration in, 393.
laparotomy in, 394.
Inversion in narcosis, 35.
Issues, 329.
by caustic, 330.
incision, 330.
moxa, 331.
seton, 329.

Jaw, anchylosis of lower, 649.
Jejunum, intussusception of, 392.
obstruction of, 395.
strangulation of, 394.
wounds of, 389, 390.
Joints, description of, 147.
diseases of, 154.
caries, 156.
fungating, 156.
simple, 156.
excision of, 168.
inflammation, 154.
loose bodies, 167.
origin of, 154
operations and injuries of, 147, 168.
special operations, 154.
wounds of, 147.
contused, 147.
incised, 147.
lacerated, 147.
punctured, 147.
Judgment, good, what constitutes, 3.

Key for compression, 20.
Kidneys, abscess of, 498.
anatomy of, 497.
calculus of, 499.
extirpation of, 502.
rupture of, 497.
Knee, dislocations of, 153.
braces, 160.
Knee-joint, amputation of, 626, 627.
anatomy, 182.
anchylosis of, 643.
caries of, 160.
excision of, 182.
after-treatment, 186.
indications, 183.
methods, 184, 185.
subperiosteal, 185.
mortality after, 182.
results of, 183.
Knife, 31.

Knife, amputation, 592.
laryngeal, 479.
manipulation of, 32
paring for palate, 351.
position of, 32.
resection, 113.
staphylorrhaphy, 351.
tenotomy, 203.
Knot, in ligation of arteries, 237.
sailor's, 22.
surgeon's, 22.
Knowledge required, 2.

Labia, adhesion of, 576.
hypertrophy of, 577.
thrombus of, 577.
Laceration of perineum, 578.
through anal sphincter, 582.
scrotal, 545.
of urethra, 533.
of rectum, 409.
Lacerated wounds, 305.
Laparotomy, 394, 396, 400.
Laparo-elytrotomy, 570.
Laparo-hysterotomy, 570.
Larynx, abscess of, 482.
anatomy of, 470.
burns and scalds of, 478.
bursal tumors of, 483.
examination of, 471.
extirpation of, 481, 482.
foreign bodies in, 475.
fracture of cartilages of, 474.
growths of, 478.
malignant, 480.
non-malignant, 478.
medication of, 472.
obstruction of, 484.
œdema of, 477.
wounds of, 473.
Laryngeal atomizer, 473.
bistoury, 480.
brush, 473.
canula, 476.
caustic holder, 472.
cutting ring, 477.
growths, 478, 480.
insufflator, 473.
knives, 479.
Laryngeal mirror, 471.
obstruction, 484.
probang, 474.
reflector, 472.
scarificator, 477.
scissors, 479.
syringe, 474.
tampon-canula, 470.
Laryngotomy, 476.
Lateral lithotomy, 522.
after-treatment, 526.
indications for, 522.
instruments for, 522.
operation of, 522.
risks in, 525.
rules to be observed in, 524.
Leech, artificial, 273.
Leeching, 272.
artificial, 273.
Leg, amputation of, 624, 626.
artificial, 659.
paralysis of, 655, 656.
Legal construction of obligation, 1.
Ligation, 21.
of arteries, 233.
aperture of sheath, 236.
dissection, 236.
incision, 236.
instruments, 233.
ligatures, 234.
application of, 237.
constriction, 237.
location of, 235.
needle passage of, 237.
of aorta, abdominal, 257.
axillary, 249.
brachial, 251.
carotid, common, 239.
external, 242.
internal, 242.
dorsalis pedis, 268.
penis, 260.
epigastric, 261.
facial, 243.
femoral, 262.
gluteal, 259.
innominate, 238.
iliac, common, 257.
external, 260.

Ligation in aneurism, 223, 233.
points of, 224, 235.
of iliac, internal, 258.
lingual, 242.
mammary, internal, 245.
occipital, 244.
peroneal, 268.
popliteal, 264.
pudic, internal, 259.
sciatic, 259.
subclavian, 239, 247.
temporal, 244.
thyroid, inferior, 246.
superior, 242.
tibial, anterior, 267.
posterior, 265.
ulnar, 254.
vertebral, 245.
operation for the, 235.
precautions, 235.
preparations, 234.
rules for head, neck, 237.
for lower limb, 256.
upper limb, 246.
wound, closure of, 237.
Ligatures, in aneurism, 235, 237.
application of, 21.
for compression, 21.
silk, 21.
hemp, 22.
catgut, 22.
Limbs, artificial, 656, 659.
dangle, 656.
Limited torsion, 23.
Lingual nerve, anatomy, 295.
artery, ligation of, 242.
methods, 243.
resection, 296.
Lips, acquired defects of, 344.
congenital defects of, 340.
hypertrophy of, 343, 344.
wounds of, 340.
operations for reconstruction of, 344, 350.
Lister's method, 42.
Lithotomy, bilateral, 531.
forceps, 523.
lateral, 522.
median, 520.
Lithotomy, medio-lateral, 521.
scoop, 523.
staffs, 519, 520, 522.
supra-pubic, 526.
Lithotrity, dangers of, 514.
operation of, 515, 516.
ordinary, 513.
perineal, 518.
preparative measures, 515.
rapid, 517.
rules to be observed, 516.
Lithotrite, Bigelow's, 514.
Thompson's, 512.
Lithotomes, 522.
Litholapaxy, 522.
evacuating apparatus for, 517.
operation of, 518.
Lithoclast, 519.
Liver, abscess of, 426.
anatomy of, 426.
gall stones in, 429.
Local anæsthesia, 30.
by carbolic acid, 30.
ether, 30.
ice, 30.
Loose bodies in joints, 167.
Lungs, anatomy of, 490.
concussion of the, 494.
hæmorrhage from the, 495.
hernia of the, 495.
puncture of cavities in, 496.
wounds of the, 494.
gunshot, 494, 499.
Lymphangitis, after wounds, 64.
Lymphatics, wounds of, 218.
Lupus, 318.
exedens, 318.
exfoliatus, 318.
exulcerans, 318.
fungosus, 318.
hypertrophicus, 318.
origin, 318.
symptoms, 318.
treatment, 319.

Mammary artery, ligation of, 245.
glands, 585.
abscess of the, 586.
extirpation of the, 588.

Mammary glands, inflammation of the, 585.
scirrhus of the, 587.
tumors of the, 587.
Manipulation of knife, 32.
in aneurism, 222.
Mastitis, 585.
Material for instrument, 14.
Meatus, contraction of, 538.
imperforate, 529.
Meatoscope, 529.
Median lithotomy, 520.
instruments for, 520.
operation of, 520.
nerve resection of, 299.
Medication, nasal, 459.
of larynx, 472.
by œsophagus, 377.
by the stomach, 381.
Medio-lateral lithotomy, 521.
operation of, 521.
Meningocele, 286.
seat, 287.
treatment, 287.
Metacarpal bones, resection of, 118.
methods, 118–120.
mortality, 118.
amputations of, 603.
disarticulations of, 603, 606.
Metacarpal joints, excision of, 169, 179.
Metacarpus, shot-fracture of, 98.
Metatarsal bones, amputation in, 616.
disarticulation of, 616, 618.
resection of, 131.
methods, 131.
Metatarsal joints, excision of, 179.
Milk, intra-venous injection of, 271.
Mirrors, rhinoscopic, 458.
Month for operations, 13.
Mortification of scrotum, 546.
Mouth gag, 351.
Movable-back saw, 115.
Moxas, application of, 331.
Muscles, general operations on, 202.
incised wounds of, 194.
injuries of, 193.
ruptures of, 193.
spasms of in wounds, 70.
special operations on, 193, 196.
Muscular system, diseases of, 196.
bursæ, 198, 199.
contraction, 199.
of fascia, 200.
of tendon, 200.
inflammation of, 196.
of tendons, 196.
injuries of, 193.
special operations on, 193, 196.
Musculo-spiral nerve, 299.
anatomy, 299.
resection, 299.
Musculo-cutaneous nerve, 298.
anatomy, 298.
resection, 298.
Myositis, 196.
Myotomy, 202.

Nævus, cutaneous, 231.
Nails, atrophy, 322.
claw-like, 324.
hypertrophy of, 322.
horny growths of, 324.
inflammation of, 322.
ingrowing, 323.
onychia, 323.
psoriasis of, 324.
Narcosis, 34.
death from, 35.
important symptoms, 34.
profound, 35.
slight, 35.
symptoms, 35.
treatment, 35.
Nasal fossæ, anatomy of, 457.
abscess of, 464.
cancer of, 469.
clamp for, 462.
douches for, 460.
hæmorrhage from, 462.
insufflators, 460, 461.
medication of, 459.
mirrors for, 458.
polypi of, 465.
speenla for, 457.
sprays for, 459.
stenosis of, 462.
Nativity in prognosis, 7.
Necrosis of bone, 109.

Necrosis of bone, partial, 109.
pathology of, 109.
total, 110.
Negligence, what constitutes, 3.
Nephritic abscess, 498.
Nerves, compression of, 282.
contusion of, 282.
lesions of, 282.
neurectomy, 293.
neurotomy, 292.
operations on, 293.
resection of, 293.
section of, 293.
stretching of, 293.
when justifiable, 293.
wounds of, 283.
ulceration of, 289.
Nervous system, anatomy of, 275.
abscess of brain, 285.
affections following wounds, 70.
constitution, 291.
delirium nervosum, 71.
delirium tremens, 71.
encephalocele, 287.
general operations on, 291.
the brain, 291.
the nerves, 293.
the spinal cord, 293.
hernia cerebri, 285.
hydrocephalus, 285.
inflammation of brain, 283.
of nerves, 289.
injuries of, 275.
compression of brain, 276.
of nerves, 282.
concussion of brain, 275.
of spine, 278.
contusion of brain, 276.
of nerves, 282.
fissure of skull, 277.
fractures of skull, 277, 278.
of spine, 280.
sprains of spine, 279.
wounds of brain, 277.
meningocele, 286.
neuralgia, 290.
neuromata, 289.
pain, 70.
spina bifida, 288.
Nervous system, subcutaneous tubercles, 289.
spasms of muscles, 70.
tetanus, 72.
ulceration of nerves, 289.
Neuralgia, 290.
causes, 290.
dissection of nerves in, 290.
of dental nerves, 290.
Neurectomy, 293.
Neuritis, 289.
Neuromata, 289.
Neuromimesis, 291.
Neurotomy, 293.
Nipple, chronic affection of, 587.
Nitrous oxide, 27.
Nose, abscess of, 464.
cancer of, 469.
foreign bodies in, 464.
imperforate, 461.
occlusion of, 461.
operations on, 455.
papillomata of, 464.
polypi of the, 465, 467.
sarcomata of, 469.
tumors, cartilaginous of, 468.
osseous of, 468.
Nostrils, occlusion of, 461.
Nurse, 16.

Obligation, civil, 1.
professional, 1.
legal construction of, 1.
Obstruction, intestinal, 395.
causes, 395.
laparatomy in, 396.
treatment, 395, 396.
Occipital artery, ligation of, 244.
Occlusion of nostrils, 461.
Odontomes, 359.
Œdema of larynx, 477.
Œsophageal forceps, 378, 379.
probang, 377.
Œsophagotomy, 380.
Œsophagus, anatomy of, 377.
catheterism of the, 378.
foreign bodies in the, 378.
medication through the, 377.
resection of the, 381.

Œsophagus, stricture of the, 380.
Office, operations in, 13.
Oleeranon process, fracture of, 87.
treatment of, 88.
Onychia, 323.
Operations, age in, 7.
arrangements for, 17.
cellulitis after, 9.
conclusion as to, 31.
consent to, 11.
constitutional diseases in, 7.
effect of intemperance on, 8.
effect of over-eating on, 8.
erysipelas, after, 9.
external conditions, 9.
for hernia, 441.
phymosis, 556.
vesico-vaginal fistula, 574.
general, on bones, 111.
on joints, 168.
nervous system, 291.
muscles, 202.
circulatory system, 232.
arteries, 233.
capillaries, 272.
heart, 232.
veins, 269.
in acute inflammation, 9.
influence of abdominal plethora, 8.
affections of heart, 9.
anæmia, 8.
degeneration of arteries, 9.
diseased veins, 9.
disease of lungs, 9.
dyspepsia, 8.
enlarged liver, 8.
kidney diseases, 9.
menstruation and pregnancy, 9.
nervous affections, 9.
rheumatism and gout, 7.
scrofula, 7.
shock, 9.
strumous affection, 9.
syphilis, 7.
of castration, 551.
laryngotomy, 476.
thyrotomy, 475, 477.
tracheotomy, 475, 484.
Operations, on tegumentary system, 302, 313, 325.
result of, 31.
rhinoplastic, 455, 456.
special, on bones, 101.
on circulatory system, 213, 220.
joints, 147, 154.
muscles, 193, 196.
nervous system, 275, 283.
when justifiable, 10.
Orchitis, syphilitic, 550.
Osteotomy, 635.
Osteoclast, 635.
Osteoplasty, 146.
Osteo-myelitis, 107.
Os calcis, resection of, 133.
Ovarian cyst, 561.
inflammation, 559.
trocars, 561, 563, 564.
Ovaries, anatomy of, 559.
cystic tumors of, 561.
inflammation of, 559.
removal of, 560.
tapping the, 561, 562.
Ovariotomy, affusion after, 565.
clamp, 564.
operation of, 563.
preliminary measures, 563.
trocars, 563, 564.
Ovaritis, 559.
operative treatment, 560.

Pain in wounds, 70.
Palate, anatomy, 350.
cleft, 351.
operations on the, 352, 354.
instruments for, 351.
soft, contraction of, 356.
Papillomata, nasal, 464.
Paracentesis thoracis, 492.
indications for, 492, 493.
instruments for, 492.
methods, 493.
of pericardium, 233.
Paralysis, appliances for, 654, 656.
Paraphymosis, 556.
Parenchymatous hæmorrhage, 61.
Parotid gland, anatomy, 362.
abscess of the, 363.

Parotid gland, calculi of the, 363.
extirpation of the, 365.
fistulæ of the, 363.
tumors of the, 364.
wounds of the, 362.
Patella, fracture of, 91.
dislocation of, 153.
non-united fracture of, 652.
resection of, 136.
Patient, preparation of, 11.
Penis, amputation of, 558.
anatomy of, 555.
cancer of the, 557.
circumference of, 529.
extirpation of, 558.
injuries of the, 555.
Perineal lithotrity, 518.
indications for, 518.
instruments for, 518.
operation, 519.
nerve, resection of, 300.
Perineorraphy, 579, 580, 583.
Perinephritic abscess, 498.
Perineum, laceration of, 578, 582.
operative methods, 579, 580, 583.
Periosteotome, 113, 351.
Periostitis, 106.
Peroneal artery, ligation of, 269.
Peroneal nerve, resection of, 300.
Phagedæna in repair of wounds, 62.
Phalanges, amputation of, 599, 600.
dislocation of, 151.
distortion of, 634, 642.
flexion of joints of, 634.
resection of, 118, 130.
shot fracture of, 98.
supernumerary, 633.
webbed, 633.
Phalangeal joints, anchylosis of, 642.
excision of, 169, 179.
Pharynx, abscess of, 376.
anatomy of, 375.
foreign bodies in, 376.
inspection of, 375.
wounds of, 376.
Pharyngeal abscess, 376.
mirror, 375.
Phimosis, 555.
operation for, 556.
Phlegmonous inflammation, 316.
Physical examination, 6.
Place for operations, 13.
Plantar nerve, internal, 301.
anatomy of, 301.
resection of, 301.
Plastic apparatus, 53, 81.
bandages, 81.
objections to, 81.
gypsum splint, 54.
silica bandage, 54.
starch bandage, 54.
precautions needed, 53.
shears for cutting, 55.
Pleura, wound of, 491.
collection of pus in, 496.
Pneumocele, 495.
Poisoned wounds, 310.
Polypus forceps, 465.
snare, 466.
rectal, 413.
treatment, 414.
uterine, 563.
Polypi of the tongue, 370.
nasal, 465, 467.
Popliteal artery, anatomy of, 264.
aneurism of, 257.
treatment, 257.
ligation of, 264.
methods, 264, 265.
wounds of, 217.
nerve, resection of, 300.
Position of wounds, 41.
Preparation of patient, 11.
Preservation of instruments, 15.
Principles of an art, 1.
Probang, laryngeal, 474.
Probangs, 377.
Prognosis, age, in 7.
constitutional diseases in, 7.
deranged conditions of organs, 8.
habits and temperament in, 8.
nativity in, 7.
other affections in, 9,
sex in. 7.
Progress of disease, 6.
Prolapse of rectum, 412.
treatment, 112.
Prostate gland, anatomy, 552.

Prostate gland, hypertrophy of, 552.
catheterism in, 553, 554.
diagnosis of, 553.
injuries of the, 552.
Prostatic catheters, 554.
guide, 555.
Pyæmia, causes, 68.
Pyæmic fever, 68.
Pseudarthrosis, 650.
drill in, 650.
friction in, 650.
resection in, 651.
section, subcutaneous in, 651.
Psoriasis of nails, 324.

Qualifications of surgeon, 2.
knowledge, degree of, 2.
limit to, 2.
lowest grade of, 2.

Radial artery, wounds of, 216.
ligation of, 253.
methods, 253, 254.
nerves, resection of, 299.
Radius, fracture of, 85.
elucidation of, 85.
and ulna, fracture of, 88.
and ulna, resection of, 124.
non-united fracture of, 651.
resection of, 120.
after-treatment, 120.
methods, 121.
mortality, 120.
shot fracture of, 97.
Ranula, treatment of, 370.
Rapid respiration, 30.
Reconstruction of lips, 344, 350.
Rectal abscess, 409.
cancer, 415.
dilators, 402.
exploration, 405, 406.
medication, 407.
polypus, 413.
prolapse, 412.
speculæ, 406, 407.
stricture, 416.
syringes, 407.
Rectotomy, 411, 412.
Rectum, abscess near, 409.
Rectum, absence of, 409.
alimentation by, 408.
anatomy of the, 405.
cancer of the, 415.
exploration of the, 405, 406.
extirpation of, 415.
with prostate and base of the bladder, 416.
foreign bodies in, 414.
imperforate, 408.
laceration of, 409.
medication by, 407.
polypus of the, 413.
prolapse of, 412.
speculæ for, 406, 407.
stricture of, 410.
Refracture of bones, 634.
Refrigerator, 30.
Renal abscess, 498.
calculi, 499.
Repair after operations, 56.
antiseptic method in, 58.
complications of, 60.
different treatment in, 58.
fevers during, 57, 65.
gangrene during, 61.
hæmorrhage during, 60.
hot-water dressing in, 59.
indications of, 56.
inflammations in, 63.
nervous affections in, 70.
normal, 57.
ordinary dressings in, 58.
pulse in, 57.
wound changes in, 57.
Resection, 112.
indications, 112.
instruments, 112–116.
of bones, 112.
astragalus, 133.
clavicle, 128.
coccyx, 137.
cuboid, 132.
cuneiform, 132.
femur, 136.
fibula, 134.
humerus, 124.
inferior maxilla, 139.
metacarpal bones, 118.

Resection of metatarsal bones, 131.
os calcis, 133.
patella, 136.
phalanges of fingers, 118.
phalanges of toes, 130.
radius, 120.
and ulna, 124.
ribs, 138.
sacrum, 137.
scaphoid, 133.
scapula, 127.
sternum, 138.
superior maxilla, 142, 145.
tarsal, 132.
tibia, 135.
ulna, 122.
vertebræ, 137.
of nerves, 293.
indications, 293.
rules, 293.
brachial plexus, 297.
cutaneous, internal, 298.
dental inferior, 296.
digital, 299.
lingual, 296.
median, 299.
musculo-cutaneous, 298.
musculo-spiral, 299.
perineal, 300.
peroneal, 300.
plantar, internal, 301.
popliteal, 300.
radial, 299.
saphenous, external, 301.
internal, 301.
sciatic, great, 300.
small, 300.
supra-maxillary, 295.
orbital, 294.
tibial anterior, 300.
posterior, 300.
ulnar, 299.
of œsophagus, 381.
operation of, 116.
time for, 112.
treatment of wounds, 117.
Respiration, artificial, 35, 36.
Responsibility in operations, 4.
Resuscitation in narcosis, 35.
Retention of urine, 511.
Retractors, 113.
Retro-pharyngeal abscess, 376.
Retroversion of uterus, 567.
repo-itor for, 568.
Rhinoplasty, 455.
operative methods, 455, 456.
Rhinoscopy, 458.
instruments for, 458.
Rhinoscope, 458.
Ribs and cartilages, fracture of, 82.
complications, 82.
treatment, 101.
resection of, 138.
methods, 138.
Rickets, treatment of, 101.
Rings, elastic, 19.
Room for convalescent, 16.
for operating, 13.
Rubefacients, 327, 328.
action of, 327.
Ruptures of arteries, 214.
of bladder, 507.
kidney, 497.
muscles, 193.
spleen, 430.
tendons, 194.

Sacrum, resection of, 137.
Saphenous nerve, external, 301.
exposure of, 301.
internal, resection of, 301.
Sarcomata, 104.
of skin, 320.
nasal, 469.
Sarcoma of testicle, 551.
Saw, chain, 114.
circular edge, 115.
curved, 115.
movable back, 115.
oval, 351.
spring, 115.
straight, 115.
subcutaneous, 648.
Scalds, 312.
cicatricial contractions in, 313.
degrees, 312.
Scaphoid bone, resection of, 133.
Scapula, resection of, 127.

Scapula, methods of resection, 127, 128.
Scarification, 273.
Sciatic artery, ligation of, 259.
nerve, great, 300.
resection of, 300.
nerve, small, resection of, 300.
Scissors, curved, 574.
for tonsils, 366.
for vulva, 357.
laryngeal, 479.
Scoop, lithotomy, 523, 525.
Scrotum, cancer of, 547.
contusion of, 545.
elephantiasis of the, 546.
hydrocele of, 547.
inflammation of the, 545.
laceration of the, 545.
mortification of the, 546.
varicocele, 547.
Secondary hæmorrhage, 60.
Section of nerves, 293.
indications for, 293.
of brachial plexus, 297.
cutaneous internal, 298.
dental inferior, 296.
digital, 299.
lingual, 296.
median, 299.
musculo-cutaneous, 298.
musculo spiral, 299.
perineal, 300.
peroneal, 300.
plantar internal, 301.
popliteal, 300.
radial, 299.
saphenous, external; 301.
internal, 301.
sciatic, great, 300.
small, 300.
supra maxillary, 295.
supra-orbital, 294.
tibial, anterior, 300.
posterior, 300.
ulnar, 299.
rules, 293.
Cæsarean, 570.
Septicæmia, 67.
Septic fever, 67.
inflammation in wounds, 64.
Sequestrotomy, 111.
direct method, 111.
indirect method, 111.
Setons, application of, 329, 330.
Sex in prognosis, 7.
Shock, 37.
severity of, 37.
Shot fractures, 96.
of clavicle, 97.
femur, 99.
humerus, 97.
inferior maxilla, 97.
metacarpal bones, 98.
phalangeal bones, 98.
radius and ulna, 97.
superior maxilla, 96.
tibia and fibula, 100.
varieties, 96.
Shoulder joint, anchylosis of, 643.
amputation of, 611.
by double flap, 613.
oval method, 611.
single flap, 612.
Shoulder, dislocation of, 149.
compound, 150.
reduction of, 150.
subspinous, 150.
excision of, 176.
indications, 177.
methods, 178.
mortality from, 177.
results of, 177.
subperiosteal, 179.
treatment of, 179.
Silica bandage, 65.
Silk ligature, 21.
Skill, implied, 2.
Skin, diseases of, 313.
injuries of, 302.
operations on, 325.
transplantation of, 76, 335.
Skull, fissures of, 277.
fractures of, 277, 278.
Sound, tunneled, 542.
vesical, 503.
urethral, 529.
Spasms, muscular in wounds, 70.
Speculæ, vaginal, 572.
nasal, 457.

Specula, rectal, 406, 407.
Spermatic cord, hæmatocele of, 548.
hydrocele of, 548.
varicose veins of, 548.
Spina bifida, 288.
Spine, caries of, 162.
concussion of, 278.
fractures of, 280.
railway injuries of, 279.
sprains of, 279.
trephining of, 293.
Spinal abscess, 166, 167.
caries, 162.
apparatus for, 165, 166.
Spleen, anatomy of, 430.
hypertrophy of, 430.
rupture of, 430.
wounds of, 430.
Splenotomy, 431.
Splints, gypsum, 81, 88, 92–94.
for hip-joint disease, 159.
application of, 159.
gypsum for hip, 192.
Sprains of spine, 279.
Sprays, nasal, 459.
Spring saw, 115.
Staff, lithotomy, 519, 520, 522.
Staphylorraphy, 352.
knife, 351.
operative methods, 352, 353.
sutures in, 354.
Starch bandage, 54.
Stenosis, nasal, 462.
Sterno-clavicular dislocation, 149.
reduction, 149.
Sternum, resection of, 138.
Stomach, anatomy of, 381.
alimentation by fistula of, 382.
foreign bodies in, 387.
pumps, 381.
wound of the, 386.
Straight saw, 115.
Strangulation of intestines, 394.
Stretching of nerves, 293, 294.
Stricture of colon, 401.
dilatation of, 402.
colotomy in, 403.
exploration of, 402.
of œsophagus, 379.
Stricture of œsophagus, dilatation of, 380.
of the urethra, 536.
dilatation of, 539.
division of, 539, 542.
divulsion of, 539, 540.
location of, 536.
permanent, 536.
recontraction of, 539.
spasmodic, 536.
symptoms, 536.
treatment of, 538.
varieties of, 536.
rectal, 410.
after treatment, 412.
diagnosis, 410.
dilatation of, 411.
incision of, 411.
rectotomy in, 411.
Subclavian artery, anatomy, 247.
aneurism of, 246.
direction of, 247.
ligation of, 239, 247, 248.
precautions, 249.
Sublingual gland, 362.
abscess of, 363.
calculi of, 363.
fistulæ of, 363.
tumors of, 364.
wounds of, 362.
Submaxillary gland, 362.
abscess of, 363.
calculi of, 363.
extirpation of, 365.
fistulæ of, 363.
tumors of, 364.
wounds of, 362.
Suggillation, 217.
Superior maxilla, resection of, 142.
methods, 142–145.
shot fracture of, 96.
Superior maxillary nerve, 295.
resection of, 295.
section of, 295.
Supra-orbital nerve, anatomy, 294.
resection, 294.
section, 294.
Supra-pubic lithotomy, 526.
Suspension apparatus, 163.

Suture adjuster, 351.
forceps, 47.
interrupted, 46.
materials for, 47.
needle, spiral, 351.
needles for, 47.
quilled, 47.
twisted, 47.
Syncope: symptoms, treatment, 37.
Synovial sheaths, inflammation of, 197.
Synovitis, chronic, 155.
parenchymatous, 154.
serous, 154.
Syringe, laryngeal, 474.
Syringes, rectal, 407.

Table, gynæcological, 573.
Talipes calcaneus, 638.
equinus, 637.
valgus, 640.
varus, 636, 639.
Tampon-canula, laryngeal, 480.
Tapping in ascites, 435.
the ovary, 561, 562.
Tarsal bones, dislocations of, 153.
resection of, 132.
Tarsal joints, excision of, 179.
Tarso-metatarsal disarticulation, 618.
Tarsus, disarticulation of, 620.
Teeth, extraction of, 360.
Tegumentary system, 302, 313.
acupuncture, 329.
applications, endermic, 328.
diseases of, 313.
acne rosacea, 321.
callosity, 313.
carbuncle, 315.
cellulitis, 316.
corn, 314.
cutaneous horn, 314.
elephantiasis, 319.
epithelioma, 320.
erysipelatous inflammation, 314.
fibrous tumor, soft, 320.
furuncle, 315.
hair, overgrowth, 320.
lupus, 318.
nail, atrophy of, 322.
claw, 324.
Tegumentary system, diseases of, —
nail, hypertrophy of, 322.
horny growths, 324.
inflammation, 322.
ingrowing, 323.
onychia, 323.
psoriasis, 324.
retained secretions, 321.
sarcomata, 320.
ulcer, 317.
warts, 314.
general operations on the, 325.
injections, hypodermic, 331.
injuries of, 302.
burns, 312.
chilblains, 311.
contusion, 302.
frost-bite, 311.
scalds, 312.
wounds, contused, 305.
incised, 303.
gunshot, 305.
lacerated, 305.
poisoned, 310.
issues in, 329.
operations on, 302, 313, 325.
rubefacients, 327.
thermometry, 325.
transplantation of skin, 335.
vaccination, 332.
vesicants, 328.
Telangiectasis, 231.
Temporal artery, ligation of, 244.
Temporo-maxillary dislocation, 148.
Tenaculum, 21.
forceps, 21.
for tonsil, 366.
Tendons, contraction of, 20.
inflammations of, 196.
rupture of, 194.
causes, 194.
of biceps flexor cubiti, 195.
quadriceps extensor, 195.
tendo-Achillis, 195.
triceps extensor cubiti, 195.
wounds of, 195.
Tendo-Achillis, division of, 209.
Tenotomy, 20.
after-treatment of, 204.

Tenotomy, discrimination in, 202.
indications for, 202.
instruments for, 203.
of adductor longus, 210.
biceps flexor cruris, 209.
cubita, 206.
deltoid, 206.
extensor longus digitorum, 207.
proprius pollicis, 207.
extensors of fingers, 205.
flexor carpi radialis, 205.
ulnaris, 205.
flexors of fingers, 204.
gracilis, 210.
latissimus dorsi, 207, 212.
longissimus dorsi, 211.
longus digitorum, 207.
pollicis, 207.
multifidus spinæ, 211.
palmaris longus, 206.
pectineus, 210.
pectoralis major, 206.
peroneus brevis, 209.
longus, 209.
tertius, 209.
quadriceps extensor, 210.
sacro-lumbalis, 211.
sartorius, 210, 211.
semi-membranosus, 210.
semi-tendinosus, 210.
sterno-cleido mastoid, 212.
tendo-Achillis, 209.
tensor vaginæ femoris, 211.
teres major, 207.
thumb, 205.
tibialis anticus, 208.
posticus, 208.
trapezius, 212.
triceps extensor cubiti, 206.
operation of, 203.
Tenotomes, 203.
Testicles, 545.
cancer of the, 551.
epididymitis, 549.
extirpation of, 551.
hæmatocele of, 549.
orchitis, 550.
sarcoma of, 551.
tubercles of, 551.
Tests for instruments, 15.
Tetanus, symptoms, treatment, 72.
Thermo-cautery, 25.
Thermometers, 325.
uses of, 325, 326.
varieties of, 325.
Thermometry, 325.
rules for application, 325, 326.
Thermoscope, 327.
Thigh, amputation of, 628.
by antero-posterior flaps, 629.
by lateral flaps, 629.
artificial, 659.
paralysis of, 655.
Thorax, foreign bodies in, 492.
injuries of the, 491.
tapping the, 249.
Thrombosis, arterial, 220.
venous, 225.
Thrombus of labia, 577.
Thumb, amputation of, 602.
Thyroid gland, anatomy of, 488.
arteries, ligation of, 246.
inferior, 246.
superior, 246.
excision of, 489.
hypertrophy, 488.
wounds of, 488.
Thyrotomy, 477, 479.
Tibia, amputation of, 623.
fracture of, 92.
treatment, 92.
ligaments of, 135, 136.
methods, 135.
non-united fracture of, 652.
resection of, 135.
Tibia and fibula, fracture of, 93.
shot-fracture of, 100.
Tibial arteries, wounds of, 216.
artery, anterior, ligation of, 267.
methods, 267, 268.
artery, posterior, ligation of, 265.
methods, 265, 266.
nerves, resection of, 300.
Time for operations, 12.
Toes, artificial, 658.
amputations of, 614.
disarticulations of, 614, 615.
Tongue, abscess of, 370.

Tongue, cancer of, 372.
depressor, 375.
extirpation of, 373, 374.
forceps, 357.
hypertrophy of, 370.
instruments to operate on, 368.
œdema of, 370.
polypi of, 370.
-tie, treatment of, 369.
wounds of, 370.
Tonsils, anatomy of, 365.
abscess of the, 366.
cancer of the, 367.
excision of the, 366, 367.
hypertrophy of the, 366.
instruments to operate on the, 365.
serrated forceps for, 366.
scissors. 366.
tenaculum forceps, 366.
Tonsilotome, 366.
Tooth tumors, classification, 359.
Torsion, 22.
free, 23.
limited, 23.
Tourniquet, 591.
for compression, 20.
application of, 20.
Trachea, anatomy of, 483.
exploration of the, 483.
obstruction of the, 484.
wounds of, 483.
Tracheotomy, after treatment, 487.
instruments for, 485–487.
operative methods, 484, 485.
Tracheotomes, 483.
Tracheal canulas, 486, 487.
double hooks, 487.
forceps, 486, 487.
obstruction, 484
trocars, 487.
Transfusion, indications, 270.
methods, 270, 271.
in collapse, 38.
Transplantation of skin, 76, 335.
indications for, 335.
methods, 335.
by approximation, 336.
sliding, 336.
transfer, 336.
Transplantation of skin, operations for, 337.
rules to be observed, 335.
sutures in, 336.
Traumatic gangrene, 71.
fever, 66.
Trephining, 145.
method, 146.
the cranium, 291.
the spine, 293.
Trephines, 145.
Trocar, dome, 564.
ovarian, 561, 563, 594.
Trusses for herniæ, 443, 444.
Tubercles, of testis, 551.
painful subcutaneous, 289.
Tumors of bone, 102.
characteristics, 102.
diagnosis of, 103.
rules for treatment, 103.
carcinomata, 105.
chondromata, 103.
exostoses, 103.
fibromata, 105.
sarcomata, 104.
Tumors, bursal of larynx, 483.
connective tissue, 320.
cystic ovarian, 561.
malignant of larynx, 480.
nasal, 468.
non-malignant, 478.
of abdominal walls, 434.
of breast, 587.
removal of, 588.
soft, fibrous, 320.
of salivary glands, 364.
nature, 364.
operations for removal, 364, 365.
seat, 364.
of tooth, 359.

Ulcer, 317.
callous, 318.
erethitic, 317.
fungous, 317.
treatment, 317, 318.
Ulna, resection of, 122.
methods of, 122, 123.
mortality after, 122.

Ulna, non-united fracture of, 651.
Ulnar artery, ligation of, 254.
methods, 255, 256.
artery, wounds of, 216.
nerve, resection of, 299.
Umbilicus, hæmorrhage of, 434.
morbid growths of, 434.
Umbilical growths, 434.
hæmorrhage, 434.
hernia, 452.
Uranoplasty, 354.
age for operating, 354.
conditions for success, 355.
operation of, 355.
preparatory treatment, 354.
Urethra, anatomy of, 527.
calculus of, 533.
calibre of, 527.
exploration of, 538.
foreign bodies in, 534.
imperforate, 529.
laceration of the, 533.
measurement of, 528.
prolapsus of,
stricture of the, 536.
tapping the, 544.
wounds, 533.
Urethra-meter, 528
Urethral calculus, 533.
calibre, 527.
catheterism, 504.
exploration, 538.
forceps, 534.
prolapsus,
scoop, 535.
searcher, 535.
stricture, 536.
trilabe, 535.
veins, varicose, 229.
wounds, 533.
Urethrotomes, 542, 543.
Urethrotomy, external, 543.
internal, 542.
Urine, extravasation of, 507.
retention of, 511.
aspiration in, 511.
Uterine cancer, 571.
exploration, 566.
fibroids, 568.
Uterine polypi, 568.
probes, 566.
repositor, 568.
sounds, 566.
Uterus, anatomy of, 566.
cancer of, 571.
cervical constriction of, 567.
exploration of cavity, 566.
fibrous tumors of the, 568.
polypus of the, 568.
retroversion of the, 567.
Uvula, abscess of, 357.
elongation of, 357.
instruments for operating on, 357.
scissors, 357.
Uvulatome, 357.

Vaccination, 332.
age of subject for, 333.
complications, 334, 335.
course of, 334.
performance of, 333, 334.
virus used, 333.
Vagina, exploration of, 571.
tumors of the, 576.
Vaginal fistula, 419, 574.
operative methods, 419, 420.
specula, 572.
Vaginismus, 572.
Varices, 225.
causes, 226.
Varicocele, 547.
causes, 229.
treatment, 229, 230.
Varicose veins, 226, 230.
aneurism, 219.
veins of spermatic cord, 548.
Veins, air in the, 38.
contusion of, 217.
hæmorrhoidal, 227.
internal saphena, 226.
spermatic, 229.
urethral, 229.
varicose, 226.
of spermatic cord, 548.
of urethra, 229.
venous nævi, 230.
wounds of 218.
Venesection, 269.

Venesection, from the cephalic, 270.
jugular, 270.
internal saphena, 270.
methods of, 269, 270.
Venous nævi, 230.
thrombosis, 225.
Vermiform appendix, abscess of, 397.
exploration of, 398.
operation for, 398.
perforation of, 397.
Verrucæ, 314.
Vertebræ, caries of, 162.
dislocation of, 149.
reduction of, 149.
resection of, 137.
method of, 137.
mortality after, 137.
Vertebral artery, ligation of, 245.
methods, 245, 246.
arteries, wounds of, 216.
Vesical fæcal fistula, 420.
varieties of, 421.
calculi, 512.
in women, 526.
catheters, 503.
exploration, 503.
extroversion, 505.
inflammation, 509, 510.
irrigator, 510.
sounds, 503.
wounds, 508.
Vesico-vaginal fistula, 574.
operation for, 574, 575.
Vesicants, 328.
Vocal apparatus, artificial, 481.
Vulsellum, 357.
Vulva, epithelioma of, 577.
laceration of, 578.

Ward for convalescents, 16.
Warts, treatment of, 314.
Wounds, contused, 48, 305.
cleansing of, 40.
disinfection of, 41.
drainage of, 41.
dressing of, 39.
gun-shot, 305.
gunshot of intestines, 391.
hot-water treatment, 49.
Wounds, incised, 48, 303.
of abdominal walls, 431.
punctured, 433.
treatment, 431, 433
arteries, 215, 216.
bladder, 508.
brain, 277.
bursæ, 195.
cæcum, 396.
duodenum, 389.
gunshot, 391.
heart, 213.
ileum, 389.
jejunum, 389.
joints, 147.
large intestine, 400.
larynx, 473.
lips, 340.
lungs, 495.
lymphatics, 218.
muscles, 194.
nerves, 283.
pharynx, 376.
pleura, 491.
salivary glands, 362.
spleen, 430.
stomach, 386.
tendons, 195.
thoracic parietes, 491.
thyroid gland, 488.
tongue, 370.
trachea, 483.
urethra, 533.
veins, 38, 218.
open treatment, 48.
position of, 41.
poisoned, 310.
preparation for dressing, 40.
punctured, 48.
union of, 40.
Wrist, excision of, 169.
after treatment, 172.
indications, 170.
methods, 170, 172.
results, 169.
paralysis of, 654.
dislocation of, 151.
joint, anchylosis of, 642.

DUE DATE

Printed
in USA

COLUMBIA UNIVERSITY LIBRARIES (hsl stx)
RD 32 Sm6 1881 C.1
Manual of the principles and practice of
2002189020